evoted to
EXTILE
HEMISTRY
LEACHING
DYEING
RINTING
INISHING

EMBER 9, 1946
UME 35, No. 18

AMERICAN DYESTUFF REPORTER

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of the
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AN ASSOCIATION
XTILE CHEMISTS
D COLORISTS

"Diagen" Red AFR—a new stabilized azoic color—is suitable for printing both cotton and rayon. It has very good fastness to washing, dry cleaning, pressing, and crocking. It is easy to apply and develops with great facility. Especially recommended for use whenever brightness and fastness to washing are of major importance.

Our representatives will be glad to provide you with more information on this new product. E. I. du Pont de Nemours & Co. (Inc.), Dyestuffs Division, Wilmington 98, Delaware.

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Supernylite

fast dyes for nylon

light fastness

medium shades, 40 to 300 hours

wash fastness

140° F. to 180° F.

Dye Fast Unions on Nylon and Wool
Dye Fast Unions on Nylon and Rayon
or Cotton in combination with SUPER-
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Extremely level dying in all percentages, for pastels and heavy shades on piece goods, yarns, etc

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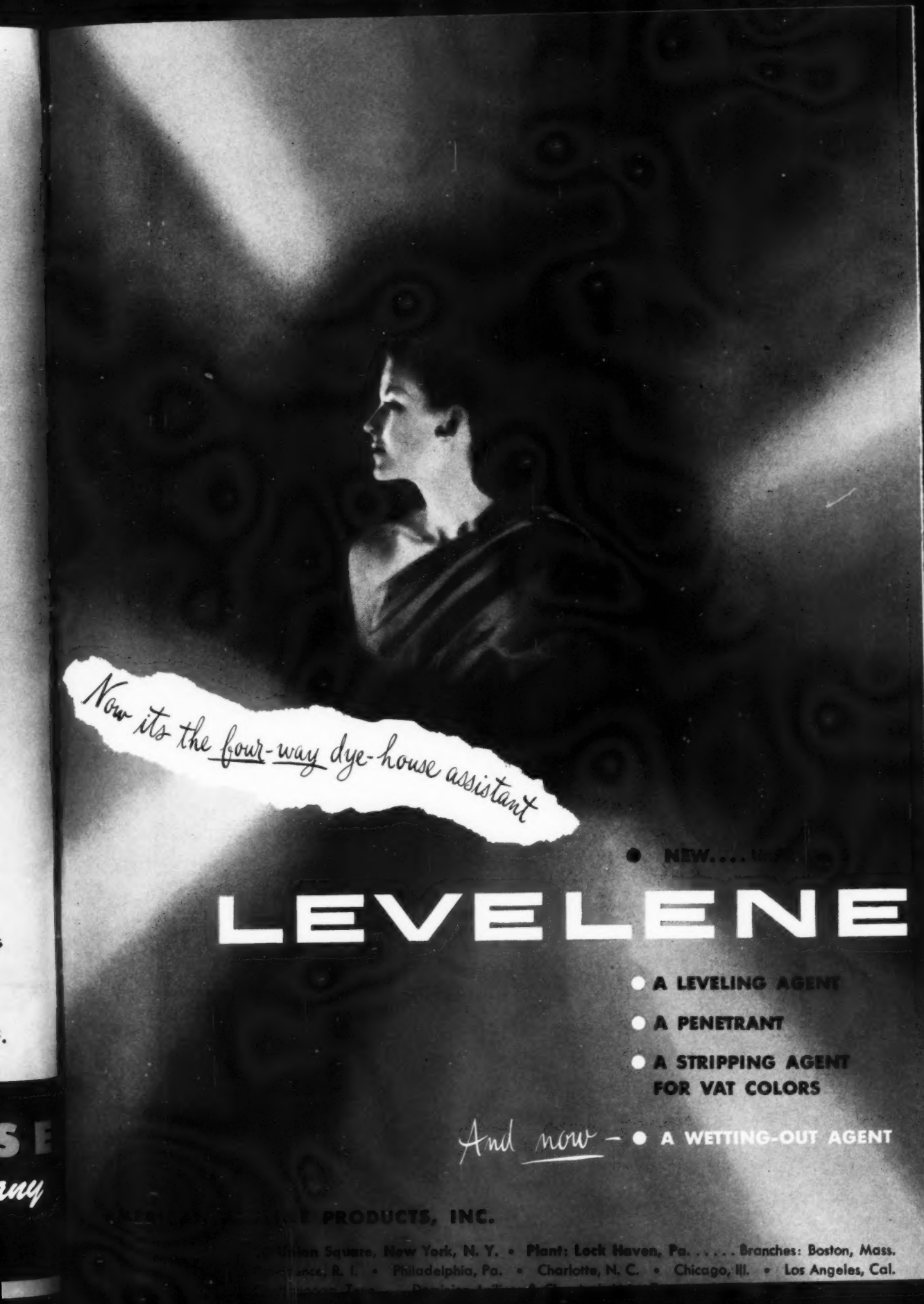
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FOR

WOOL — COTTON — RAYON — ACETATE

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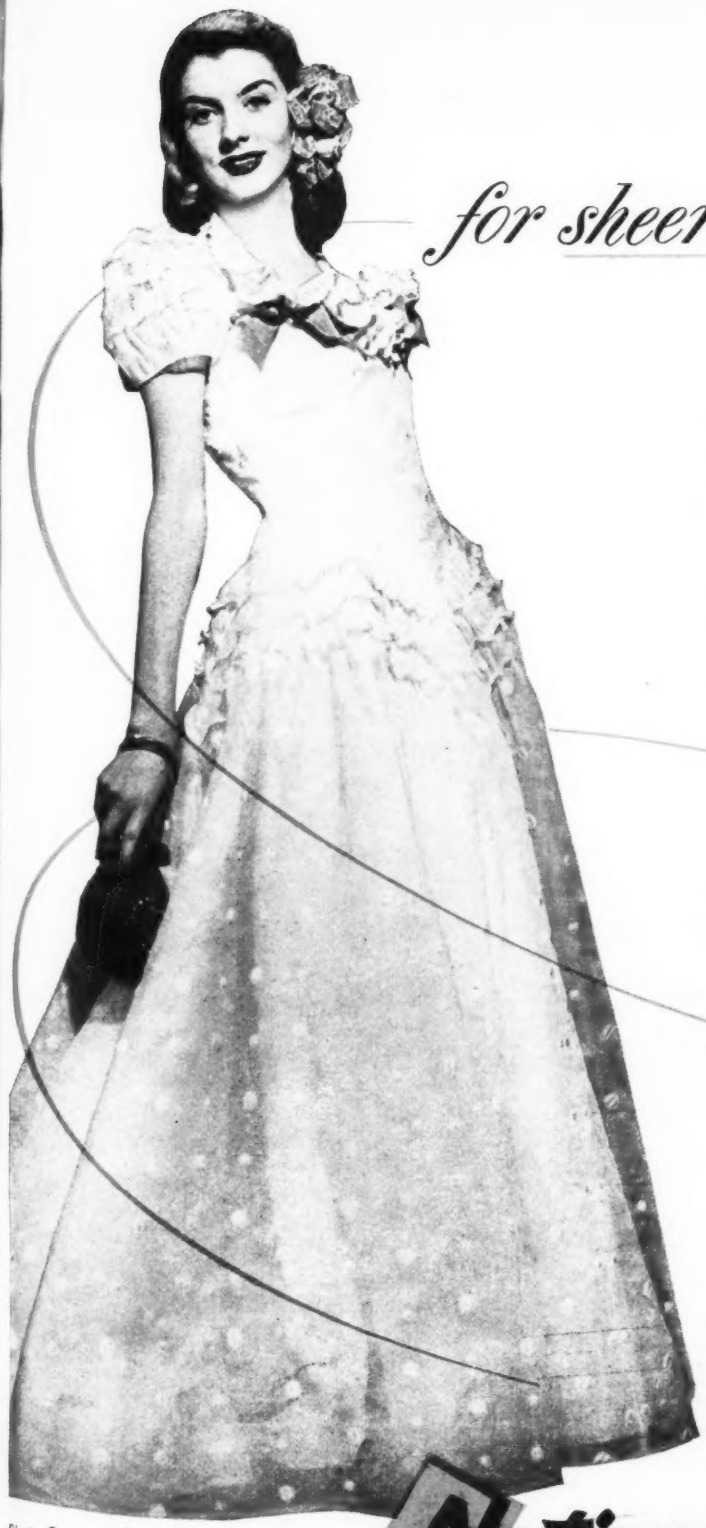

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FOR FINISHING

for sheer glamour

FIBERTEX is a thin cooking, oxidized starch derivative with uniform penetrating qualities. It is clear, colorless, non-jelling. It yields crisp, transparent finishes that are relatively unaffected by humidity changes.

FIBERTEX is an excellent, economical replacement for gelatin, gum arabic and resin finishes. It eliminates the "tailing off" of shades when dyeing and finishing are performed in a single operation. It does not reduce or bleach dyestuffs.

FIBERTEX is especially recommended for finishing cotton organdies, lawns, dimities, handkerchief fabrics, etc. It is used extensively for finishing dress goods, interlinings, nettings, veilings, elastic webbings, knit goods, etc. It also produces excellent finishes on rayon crepes, voiles, sheers and all types of spun rayon blends. Write for complete information—NOW!

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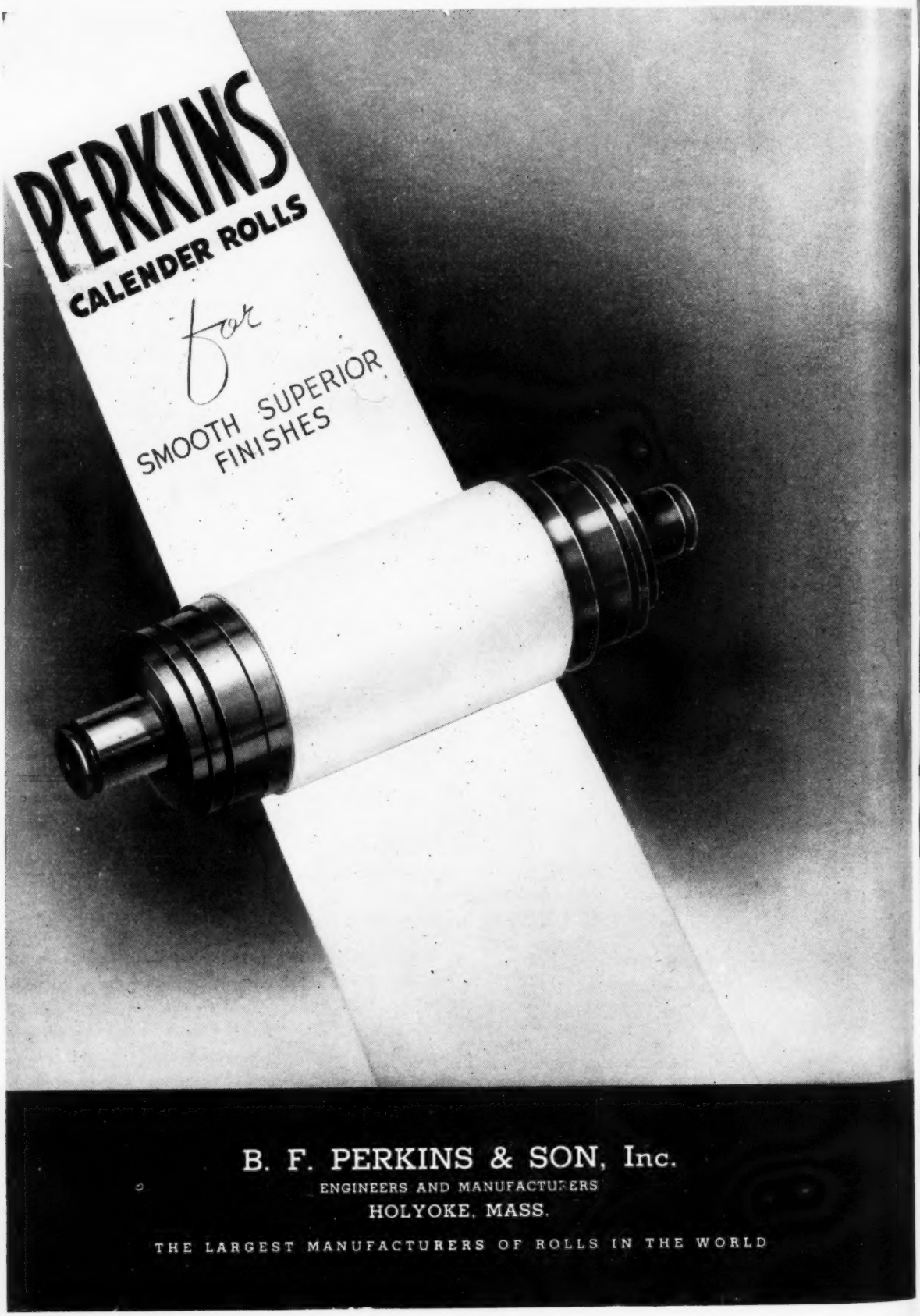
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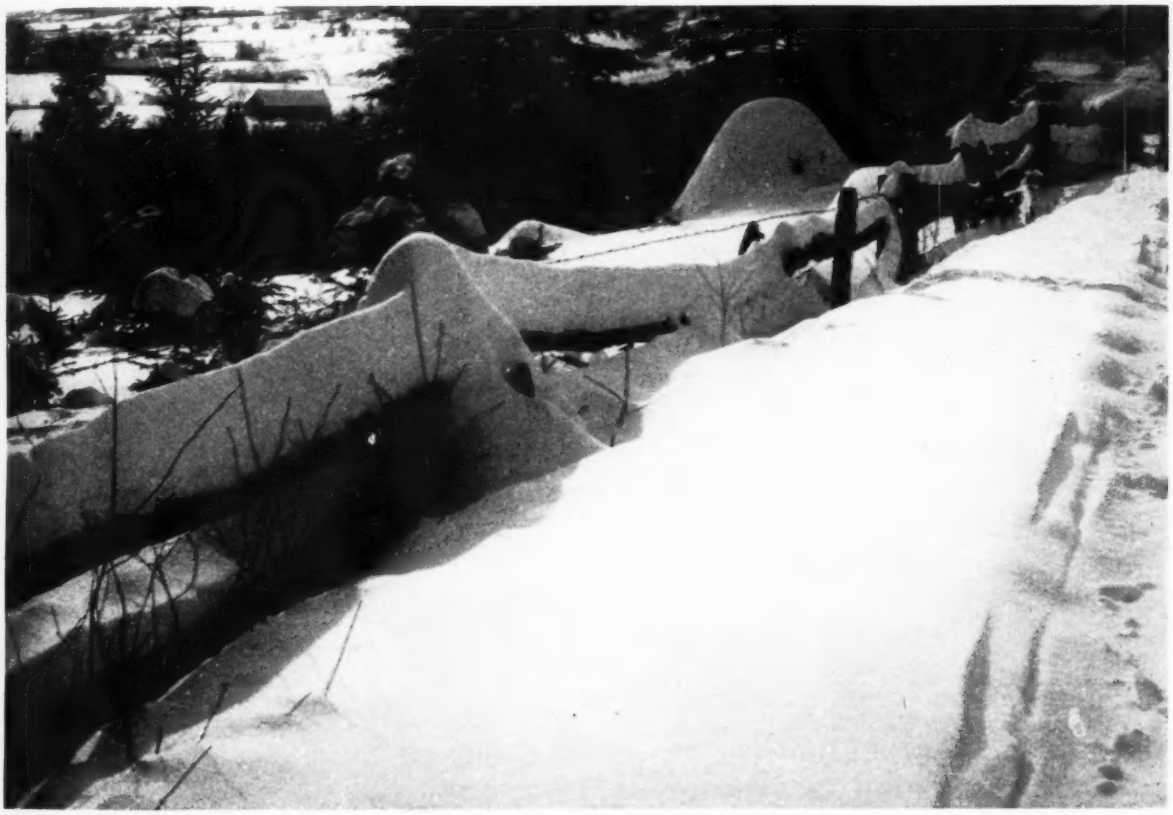

Will Not Discolor White Goods In ANY Concentration

This is only one of many unique and important features which characterize AHCOVELS E and F. Another distinctive feature is that they do *not* reduce the light fastness of any color. That is because they are anionic. Yet they have no free alkalinity,—organic or inorganic.

Other notable advantages are as follows:—

- Have approximately same resistance to hot iron scorching as an untreated fabric.
- Give a velvety soft finish with a firm full hand.
- Resistant to repeated washings or dry cleansings.
- Produce non-greasy, odorless finish, which will not discolor or develop odor with heat, age or light.
- Easy to apply; exceptionally economical to use.
- Mix readily with starches, most gums and many other finishing materials.

AHCOVEL E

—was originally developed for hard twisted fabrics, where good draping qualities are normally difficult to obtain—such as hard twist acetates and nylons. It flexibilizes the fibres.

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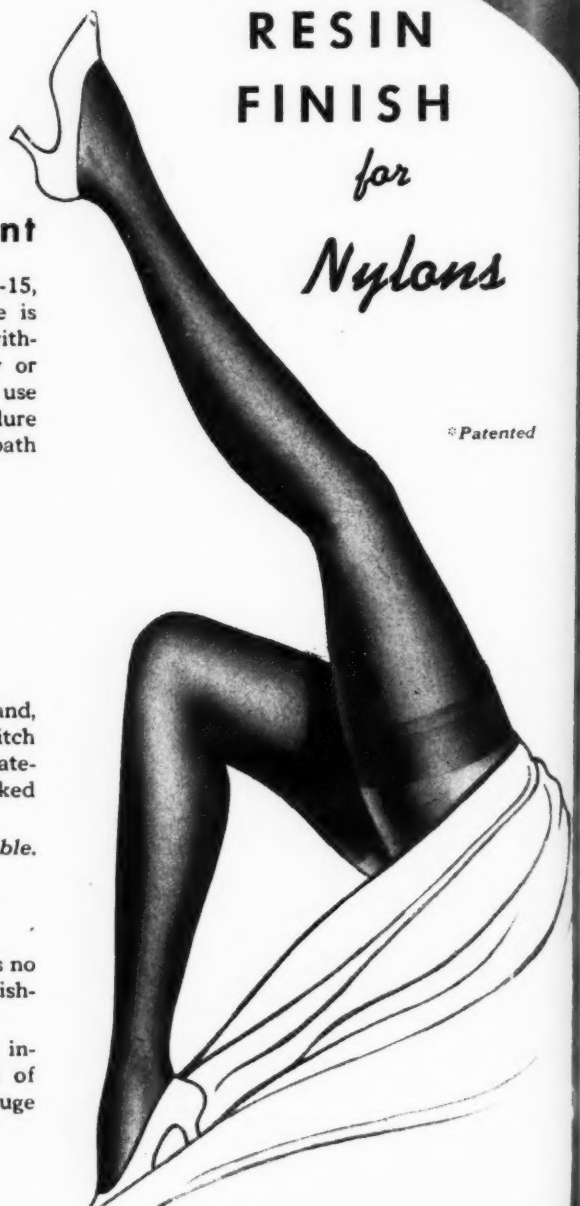

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One Finish for the Complete Treatment

WITH the development of Eternalure D-15, the finishing operation on Nylon hose is greatly simplified. Eternalure D-15 is applied, without any modifications in procedure, in rotary or paddle machines in exactly the same way you use ordinary finishes. The specific affinity of Eternalure D-15 for Nylon causes it to exhaust from the bath into the hose.

Durable Improvement in

- *BODY*
- *STITCH*
- *HAND*
- *SNAG RESISTANCE*

Eternalure D-15 imparts a much superior hand, along with highly satisfactory dulling action. Stitch is tightened and clarified. Snag resistance is materially improved. Hose is handled with a marked reduction in pull threads.

All these effects of Eternalure D-15 are durable. They last for the life of the hose.

No Hazards . . . No Compounding

This water dispersion of insoluble resins imposes no hazards of inflammability or toxicity on the finishing process.

No compounding of two or more finishes is involved. You simply use the concentration of Eternalure D-15 suited to each particular gauge and thread.

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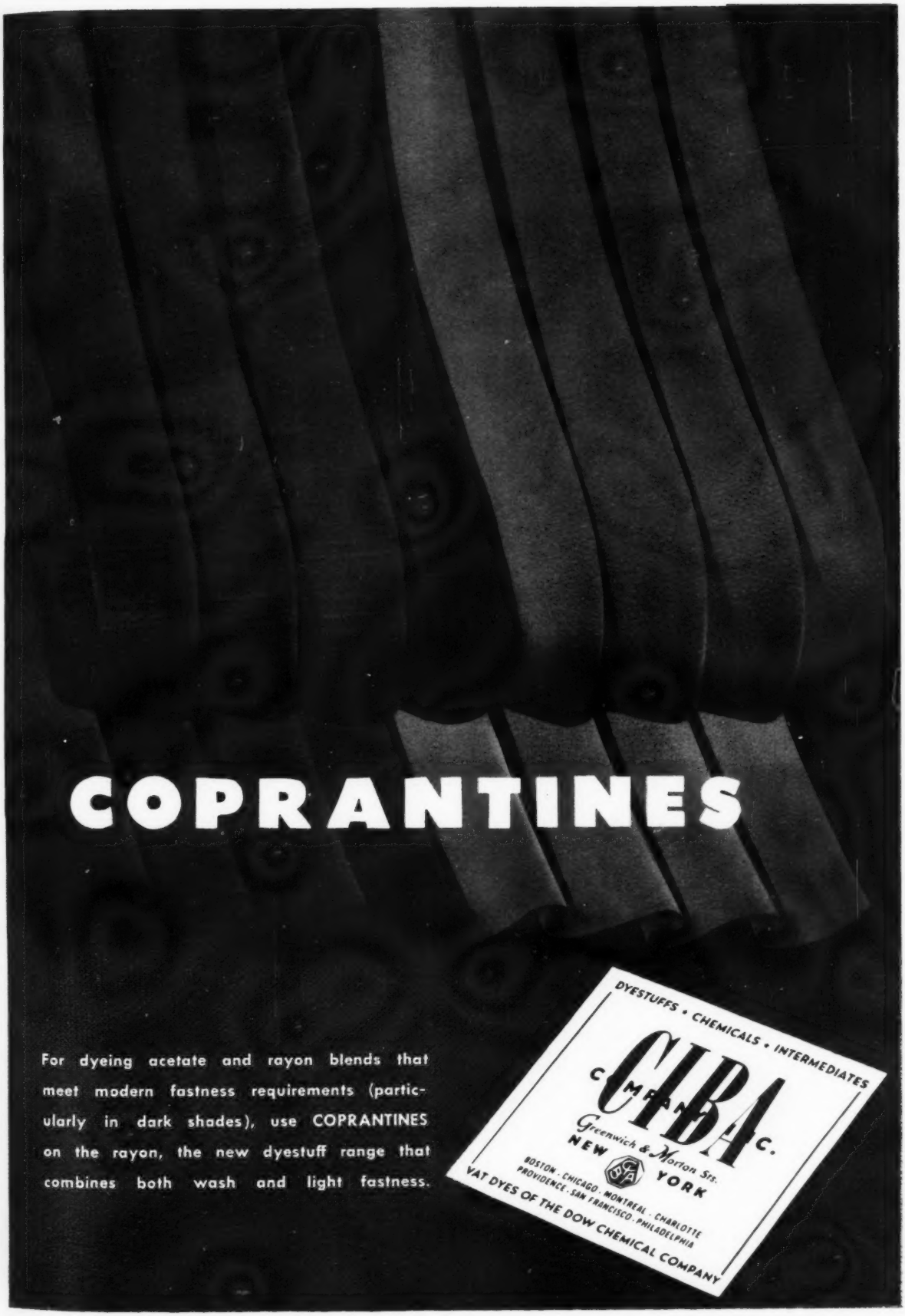
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For dyeing acetate and rayon blends that meet modern fastness requirements (particularly in dark shades), use COPRANTINES on the rayon, the new dyestuff range that combines both wash and light fastness.
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MILL MEN have found out about PARAMINE. . . . They know that to specify PARAMINE is to assure a highly desirable, wool-like texture for spun rayons, and an extra-mellow softness for all rayons, synthetics and cottons . . . and mill executives are pleased to find that PARAMINE gives this added sales value without increasing and often lowering finishing costs!

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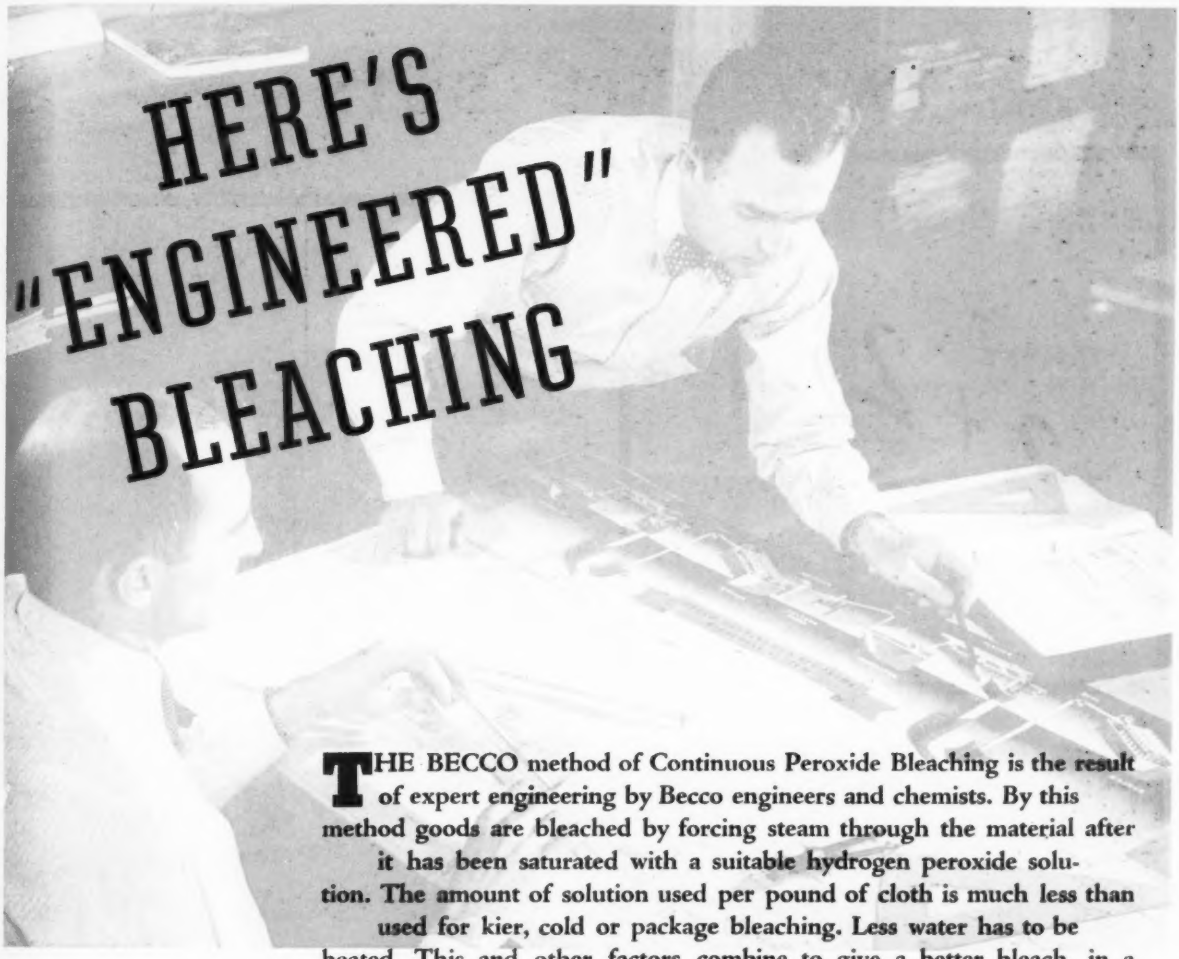

HERE'S "ENGINEERED" BLEACHING

THE BECCO method of Continuous Peroxide Bleaching is the result of expert engineering by Becco engineers and chemists. By this method goods are bleached by forcing steam through the material after it has been saturated with a suitable hydrogen peroxide solution. The amount of solution used per pound of cloth is much less than used for kier, cold or package bleaching. Less water has to be heated. This and other factors combine to give a better bleach, in a shorter time and at lower cost. Steam bleaching means higher production and shorter processing time. With the Becco continuous bleaching system temperature control is perfect.

Becco engineers and chemists do not confine their activities to the Continuous Peroxide Bleaching of textiles. They are experts in all branches of bleaching. They will be glad to survey your plant facilities and equipment and make recommendations as to how to increase bleaching efficiency and reduce costs, if possible. They will advise you truthfully whether your volume justifies the investment required for continuous bleaching or whether another method would be most economical, whether you handle cotton, wool, knit goods, rayon or other natural or synthetic fibres. They will tell you, too, at what stage of production the bleaching should be done or is most suitable.

Write to:

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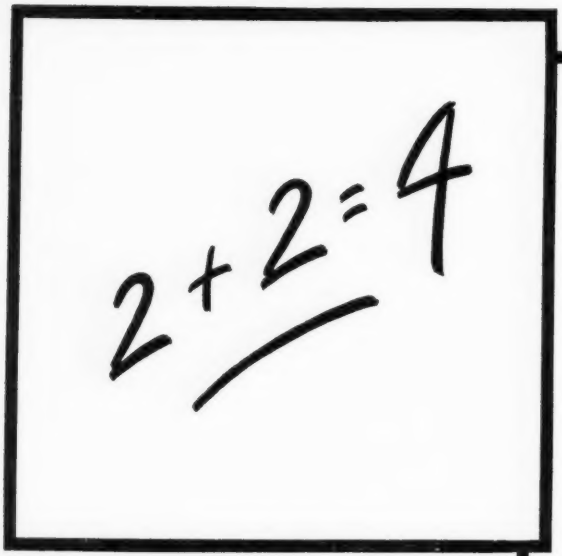
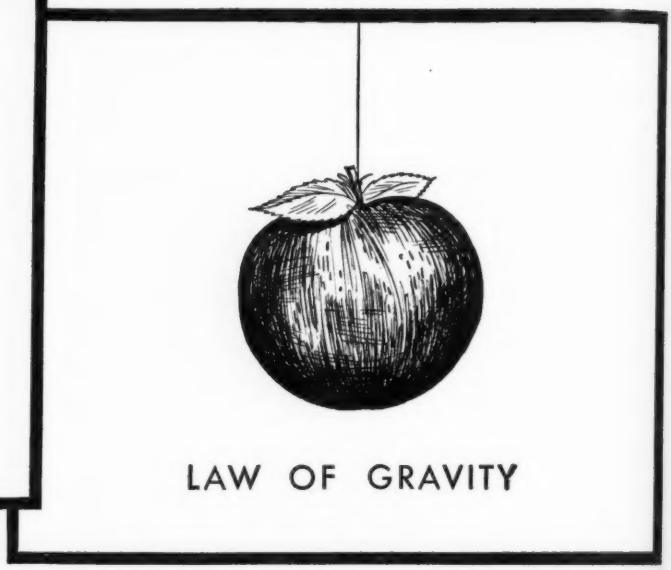




FOR SCOURING AND DYEING WOOL YARNS

SOAPS or synthetic detergents — which gets the call for scouring and dyeing woolen and worsted Yarns?

Either Olate or Orvus will give you the efficient performance so essential in the scouring operation. In dyeing, it's Orvus all the way. Olate-scoured and Orvus-dyed yarn . . . or yarn scoured and dyed with Orvus alone . . . comes out soft, lofty, resilient, clean to the core. Here are their special characteristics—judge for yourself.

Olate

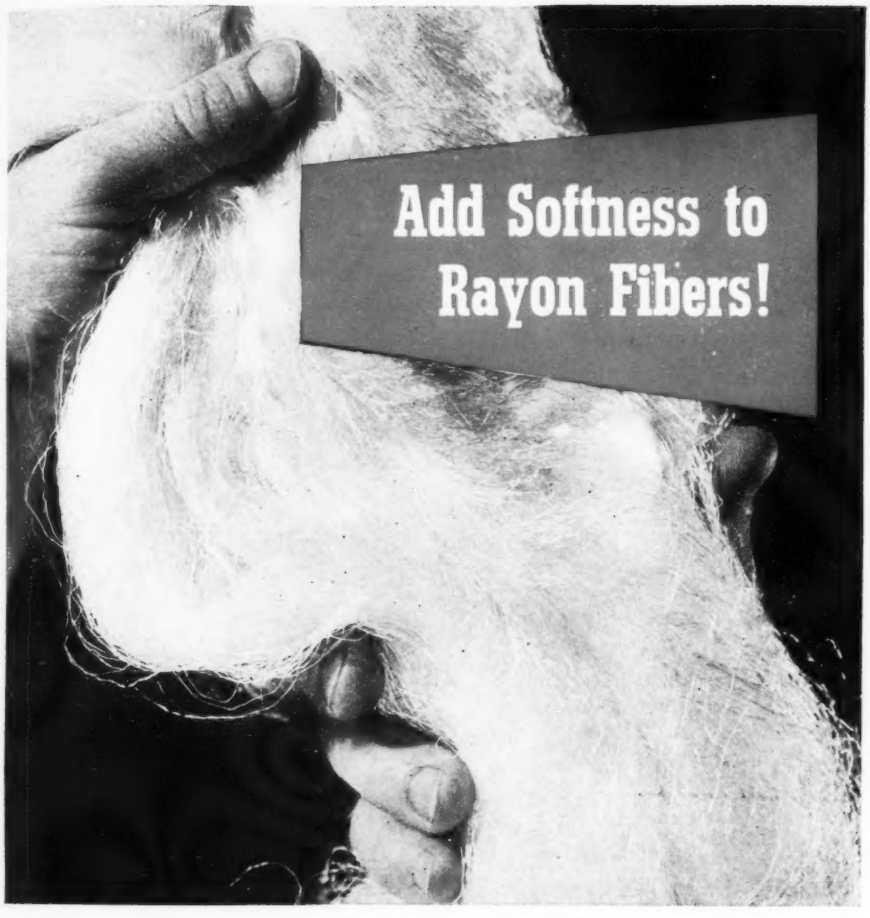
A pure, neutral flaked soap of exceptionally low titer and gentle cleansing action. • Fast dissolving. • Fluid solutions penetrate fibers quickly and thoroughly. • Excellent emulsifying properties. Holds spinning oils and dirt firmly in suspension until flushed away in rinse.

ORVUS *

A time-tested, neutral synthetic detergent. • Assures efficient removal of spinning oils. • Tends to reduce felting of yarn. • Effective in acid bath. • No hard water precipitates. • Softens and lubricates the fibers. Leaves yarn in excellent condition for subsequent operations. • Maximum safety.

* Talk over your Orvus needs with your Procter & Gamble salesman.

Procter & Gamble



S/V Rayon Soaking Oils Form Stable Emulsions; Compatible With Gelatin and Glue

★ You can be sure of excellent softness when you use S/V Rayon Soaking Oils on yarns that are to be given a high twist for knitting into hosiery or weaving into cloth.

These proved Socony-Vacuum products have high resistance to oxidation and are stable to light. They will not stain or discolor the yarn and have no objectionable odor. Further, they may be easily and economically scoured out.

S/V Rayon Soaking Oils are compatible with textile glue and gelatin, and form highly stable emulsions that won't clog up strainers or circulatory pump parts. Mildew-proofing compounds are not needed in most cases.

See your Socony-Vacuum Representative for additional details.

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Give inexpensive water repellency.

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Just the Name "Hooker" to Remember

You can find the names of all Hooker Products in a good chemical dictionary. That is, all except the most recent products of our Research Laboratories. A better place to find them is in the Hooker Products List, which contains nearly one hundred Hooker Products, their main chemical and physical characteristics, suggested uses and shipping information. But whether you want dye intermediates, mordants, catalysts, solvents or other chemicals you use, you don't have to try to remember a number of synthetic words—just think of Hooker.

A few of the Hooker Chemicals popular in the textile field are listed below. All are of the uniform high quality that insures smooth, uninterrupted operations. For further information on any of these or the other Hooker Textile Chemicals, drop us a line on your business letterhead.

PRODUCT *Chemical Formula; Molecular Weight*	HOOKER SPECIFICATIONS	SUGGESTED USES
Acetyl Chloride CH_3COCl; 78.5	Color . . . . . Clear, colorless to pale yellow Distillation Range . . . . . 95% of distillate, within 5° C including 51°C	Manufacture of chemical intermediates and dyes.
Antimony Trichloride, Anhydrous $SbCl_3$; 228.1	Antimony Trichloride . . . . . 99% Min. Iron and Arsenic . . . . . 1% Max. Lead 0%	Catalyst in organic synthesis; mordant in textile printing. Moisture and fireproofing textiles.
Benzal Chloride $C_6H_5CHCl_2$; 161.0	Clear, yellow liquid. Boiling range . . . . . 200 to 235° C Specific Gravity 15.5°/15.5°C . . . . . 1.279 ± .005	Dyestuff intermediate
Chlor Anisidine $NH_2C_6H_3ClOCH_3$; 157.5	Gray crystalline solid. Melting Point . . . . . 79°C Min. Diazo Test . . . . . Relatively clear.	Dye intermediate.
Metanitrobenzoyl Chloride $NO_2C_6H_4COCl$; 185.5	Yellow to brown liquid, partially crystallized Last crystal point . . . . . 28 to 31°C	Manufacture of dyes.
Monochlorbenzene C_6H_5Cl; 112.5	Clear, colorless liquid. Distillation Range . . . . . 131.3 to 132.3°C	Dyestuff intermediate, preparation of sulfur black, brown dyes.
Orthodichlorbenzene $C_6H_4Cl_2$; 147	Clear, colorless liquid. Freezing Point . . . . . -10 to -22°C Boiling Range 6° including . . . . . 179°C	Manufacture of pyrocatechin, dye intermediate, other synthetic organic chemicals. Degreasing wool.
Sodium Sulfhydrate NaSH; 56.1	NaSH . 70 to 72% NaCl . . . . . 1% Max. Fe . . 5ppm Max. Na_2SO, $NaHCO_3$ . . . . . 1% Max. Na_2S . . . 1 to 2% Cu, Ni, Cr, Mn, Pb . . 1 ppm Max. Water of crystallization . . . . . 28 to 26%	Desulfurizing rayon; calico printing; in sulfur dye baths.
Sodium Sulfide Na_2S; 78.1	Na_2S . . . . . 60 to 62% Fe . . . . . 8 ppm. Max. NaCl . . . . . 1.5% Max. Other Na Salts . . . . . 2.0% Max. Cu, Ni, Cr, Mn, Pb . . . . . 1 ppm. Max. Water of crystallization . . . . . 36.5 to 34.5%	Desulfurizing rayon; calico printing; in sulfur dye baths.

HOOKER ELECTROCHEMICAL COMPANY

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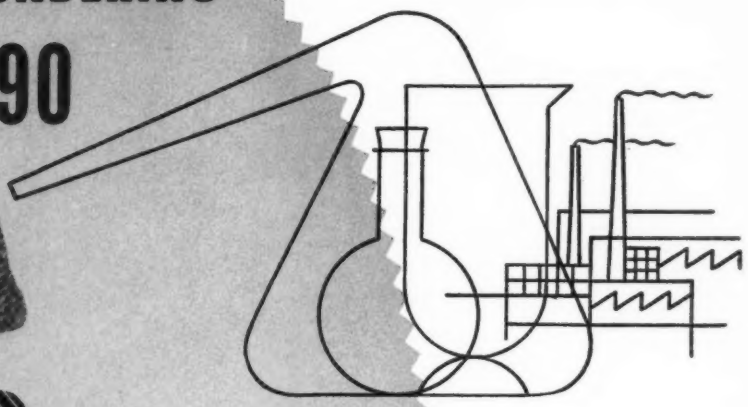
TO WITHSTAND LAUNDERING

VELVAMINE K90



This finishing and softening agent for all fabrics has a minimum effect on shade and light fastness of direct colors.

Prints are brighter and the finish is resistant to washing and dry-cleaning.

Especially recommended for starch and resin mixtures used in preparing materials for Sanforizing process, as it penetrates uniformly.

An excellent agent for rayon and cotton, used prior to spooling and knitting, where elasticity is desired.

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Each Mathieson chemical is outstanding in its own field. Each carries an important guarantee on its label — the guarantee inherent in the name of its maker. We repeat, Mathieson is that kind of a name.
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"He's the man who brings her dresses scoured with Alkamine K-50."

Alkamine K-50, the powerful new detergent that readily replaces soap without the loss of valuable soap properties, is especially effective for rayon piece goods. Faster wetting out is only the beginning of speedier production when using Alkamine K-50, for even a 1/4 to 1/2% solution assures faster, more thorough scouring as well as increased dye penetration.

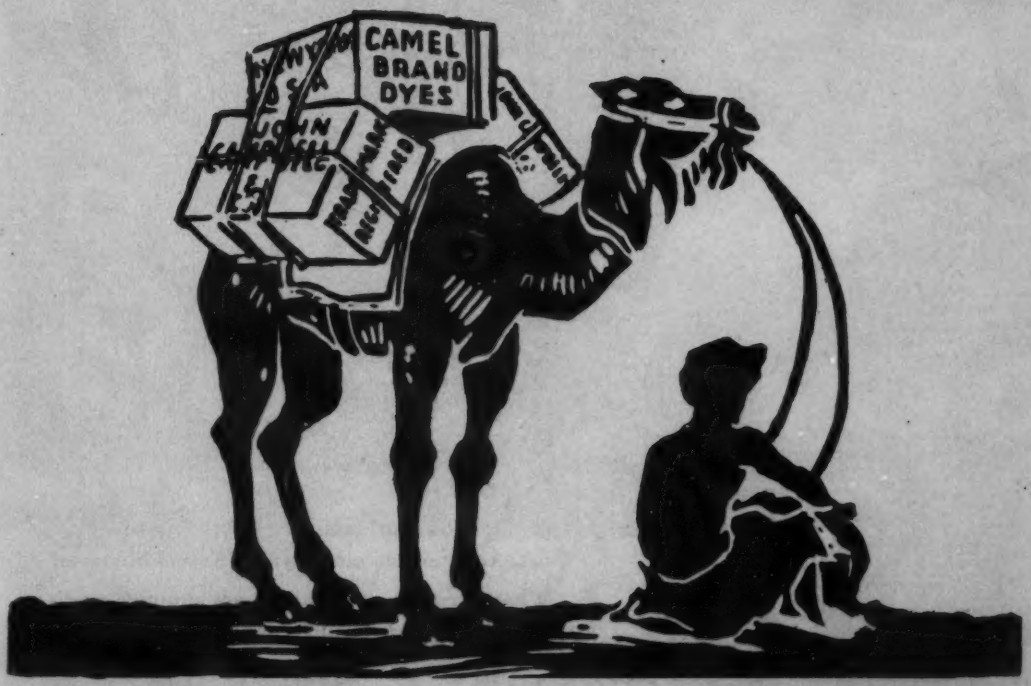
Bright, clear, more uniform colors are now possible, for Alkamine K-50 avoids streaky dyeing and eliminates lime soap deposits.

For increased production with finer results at greater profit, try Alkamine K-50, in the new and improved paste form.

ALKAMINE K-50

Amalgamated Chemical Corp., Phila. 34, Pa. :: Southern Representative: Robert A. Bruce, P. O. Box 35, Greensboro, N. C. : : Makers of a complete line of Textile Finishes, Dyeing Agents, Penetrants and Softeners.

CAMEL DYES



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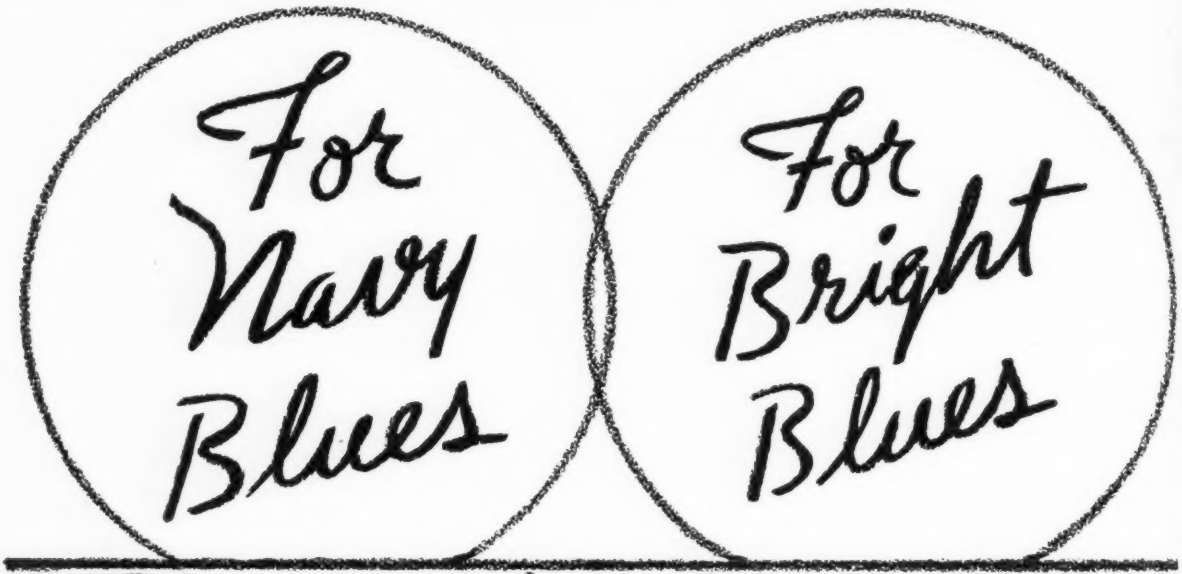

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AMERICAN
DYESTUFF REPORTER

VOLUME 35 SEPTEMBER 9, 1946 NUMBER 18

Modern Textile Finishes

FRANK W. PERRY

Manager, Textile Industry Department, Stein, Hall & Co., Inc., New York

This appraisal of the methods and present position of finishers in a world of exacting requirements and shortages was presented at the February 16, 1946 meeting of the Canadian Association of Textile Colorists and Chemists, Quebec Section, in Montreal. The appraisal does not claim to be complete, because there are far too many different types of finishing compounds and processes on the market to treat individually. But this is a clear overall survey of the finishing field today, emphasizing the exactness required as compared with "the good old days," and the difficulties caused by wartime shortages and postwar restrictions.

THE first practice of "finishing" was undoubtedly sun bleaching. The brighter, cleaner appearance of cotton cloth after exposure to the sun's rays enhanced its value. More recently the use of chemical oxidizing agents hastened this process. The art then came into being because of consumer demand for more attractive fabrics. Similarly, starches, dextrines, natural gums, clay, fullers earth, softeners and other products judiciously used by the finisher gave to fabrics a better "hand" and more eye appeal.

Coincidental with increased use of finishes, machines were developed for applying finishes, drying the fabrics, and changing their physical characteristics.

Up to this point there was little if any attempt to do more than please the eye and hand of the buyer. However, the advent of the mechanical age brought in a demand for fabrics so processed and treated that they maintained the physical characteristics specified, such as thickness, porosity, etc. Likewise, a general trend began to develop to use finishes of a more permanent type.

Demand for more durable consumer goods has risen steadily. Various institutions representing consumer groups, laundry associations, etc., sponsored this movement, and there soon appeared terms such as pre-shrunk, wash-resistant, laundry-resistant, shower-proof, waterproof, permanent, semi-permanent, anti-crease, anti-slip, wind-resistant, etc. Descriptive store advertising and advertising by chemical firms using trade name processes assisted in educating the consumer and helped to accelerate the demand for "controlled" fabrics.

Effects of War Restrictions

The war years greatly accelerated research and progress of permanent type finishes for military fabrics, but limited their applications for civilian goods. This was mainly due to imposed restrictions on materials and available labor. War-born textile finishes of a military character were of necessity of a permanent nature, and were designed to be used mostly outside North America—in the Tropics, sub-Tropics and the Arctic regions. For the most part, these finishes were produced under very exacting specifications of fabric war contracts and had to stand up under any and all almost unbelievable conditions of wear and abuse. Undoubtedly, civilian uses can and will be found for all of these special, and largely permanent, finishes although some of them wil never amount to more than a small and highly specialized line.

With this background, showing first the effect of consumer demand, then the tremendous pressure put upon our textile industry and supply houses by wartime demands, we can approach the present situation, analyze it, and perhaps indicate to some extent what future trends will be.

Methods Used Today

Textile finishing today consists of a series of mechanical treatments preceded or followed by application of chemicals—starches, gums, resins, softeners, humectants, lubricants, weighting substances, etc. Some finishes are entirely mechanical in nature, while most of them are produced by a combination of mechanical and chemical means. By changing one or more of these factors a wide variety of results may be obtained on any given fabric.

This means that much more attention must be paid to details than was necessary in former times. It means that, even with a single new product, results obtained in a few different plants are apt to vary considerably, due to the fact that a certain set of mechanical conditions in one mill is not easily duplicated in another mill. This is very often a cause for worry, not only for the mill man in trying to create a new finish, but also to the technical representative of the supply house, who is trying to duplicate results obtained in his laboratory or in another mill. These conditions call for utmost cooperation between the technicians of the finishing plant and the supply house, a condition which is much more prevalent today than in former years.

By far the greatest majority of all permanent finishing processes today employ resins of some form. The term resin is taken in its broadest meaning and might include products which, form a chemical standpoint, can hardly be termed polymeric or even be capable of undergoing polymerization. A notable exemption is the Sanforize preshrinking process, which is purely mechanical. Several other pre-

shrinking processes, however, employ resins to obtain similar results.

Finishing Materials

Of all the resins used, the urea formaldehyde types are the most popular, with the melamines gaining steadily for a place alongside the former. It is generally conceded that coating of textiles does not belong to the finishing end, but stands as a separate industry. Most of the resins and coating materials contain organic solvents which are driven off during and after the coating operation. This requires expensive solvent recovery systems not ordinarily found in a textile mill. It is for this reason that most modern finishing materials are either water soluble when applied, or are in the form of water dispersible emulsions. In order to withstand future washings, these substances, once in the cloth, are rendered insoluble by various means, such as heat, which causes a resin to polymerize, grow and become insoluble, or, if emulsified, to lose the water, causing the already formed resin particles to coalesce and form an insoluble film or deposit, or by passage through a precipitating bath, or by direct chemical action of the finishing compound on the fiber itself, and so forth.

Resin Classifications

The following is a very rough classification of the more recent finishing materials used for this purpose:

1. Formaldehyde resins, including urea-formaldehyde, thiourea formaldehyde, phenol-formaldehyde (Bakelite), melamine formaldehyde, mixtures and copolymers of an almost unlimited variety.

Their characteristics are very similar. They are all heat hardenable and then insoluble and unfusible, colorless with the exception of the phenolics, relatively simple to apply, but requiring close attention with regard to catalyst, and to curing temperatures. It is very important to use the proper type and amount of catalyst, and to guard against over or undercure of the resin in the fabric.

Another important factor is the proper choice of degree of polymerization in a given resin for the finish wanted. Quite generally a resin of a low degree of polymerization, one in which the molecules are still quite small, will penetrate much more easily, and produce a finish without much hand. Such a resin is invariably used for pre-shrinking, no-slip and anti-crease finishes. A resin of medium or high degree of polymerization stays on the surface and increases the stiffness. Such resins are used for surface effects—permanent glazed chintzes, embossing, for stiff, boardy finishes, bonding, backing, etc. It is always well to give a final wash to any fabric finished with any of the straight formaldehyde resins, to prevent odor development on storage.

These resins in general have the property of insolubilizing starches. Use is being made of this fact by adding a urea formaldehyde resin to cooked and cooled starch batches, and to finish cloth with such a mixture. Finishes with excellent wash fastness can be produced this way.

Organic Solvent Resins

2. The next group comprises several very different chemical products, but used in the same physical form of an emulsion. The resin itself is already fully formed, insoluble in water but soluble in organic solvents, and existing in the emulsion as finely dispersed particles. When applied to the fabric and dried, these particles form on the fabric, a more or less continuous film, which cannot be removed by ordinary washing.

The resins used in these emulsions belong to the polyvinylacetates, acetatechloride polymers, methyl and ethyl acrylates, methacrylates, poly styrenes, and synthetic latices. These emulsions produce a great variety of easily applied washable finishes, none of which, however, can be used for anti-crease or preshrunk effects. The latices are mostly used for duplexing cloth and for cloth backing, such as anti-slip on carpets, etc.

While the polyvinyl esters are insoluble in water, and have to be used in the form of an emulsion or in organic solvents, the polyvinyl alcohol is soluble in water, and forms very viscous solutions. Although a film of this redissolves in water and cannot be said to be permanent it can be insolubilized with metal salts, and so can be used for permanent effects.

Cellulose

3. A very important finishing agent is cellulose and some of its derivatives. The finish can be produced by altering the surface of a cellulosic fabric by chemical means, or by depositing cellulose or a cellulose derivative on the surface of the fibers. Examples of the first method are the now classical treatment of parchmentization with sulfuric acid, with cuprammonium hydroxide, and with caustic soda as in mercerization. Modern water repellants are also directly reacted on to cellulose on the surface of a fabric (Zelan, Norane).

Examples where cellulose in more or less degraded form is applied as a finish are seen in the coating of cellulose dissolved in cuprammonium hydroxide, zinc chloride, thiocyanates, xanthates, etc., and followed by precipitation of this cellulose from the solution.

Other Finishing Agents

Much more important than the dissolved cellulose itself are the cellulose ethers and acid esters as finishing agents. One of the first of these compounds was methyl cellulose, which cannot be insolubilized and is used more for a thickening agent than for finishing. Hydroxyethylcellulose and carboxy methyl cellulose can be permanently fastened to fabrics, and produce finishes of great durability. The hydroxyethylcellulose is soluble in aqueous caustic solution, in which it is applied to cloth, and precipitated by removal of the caustic by neutralization of the latter with acid. The carboxymethyl cellulose (cellulose glycolate) forms soluble salts with sodium and ammonium, in which form it can be applied to the fabric. A subsequent passage through a bath containing soluble aluminum, zinc, lead, etc., forms the corresponding insoluble metal salt.

These cellulose ethers and esters increase the weight of a fabric to a very considerable extent, and give fullness and body. They increase fabric resistance to wear and abrasion and can be applied at any stage of processing. As a matter of fact, a large yardage is processed by applying this finish to the greige goods before Kier boiling and bleaching. This indicates the degree of permanency of such compounds.

The Mechanical Angle

It might be in order to say a few words about the mechanical angle of modern finishing. While the basic mechanical aides in finishing have not undergone much change, there nevertheless have appeared a number of new or improved types of machinery without which some modern finishing could not be done very successfully. Mechanical aides include the latest types of hydraulic mangles, so necessary for efficient controlled impregnation of resin solutions; tenter frames of highly improved and controllable drying capacity; tensionless air-laid dryers for rayons and acetates; and accurately controlled hot boxes or curing ovens for setting the resins. Drying of textiles is further accomplished quite successfully with infra red radiation and with radiant heat burners, both of which types are generally added to already existing drying equipment.

The modern textile finisher is confronted with demands from the trade for a multiplicity of durable finishes, and so an increased knowledge of exacting controls of chemicals and procedures is required.

Non-Permanent Finishes

Non-permanent finishes are still with us, although little has been written about them in recent years. Perhaps one reason has been the scarcity of basic materials during the war. In the field of starches, we draw on foreign sources in normal times for many millions of pounds of tapioca, mostly from the Netherlands East Indies, large quantities of potato starch and dextrines from Holland, Sago flour from Singapore, rice starch from Belgium, etc. Practically all of this huge supply was cut off almost over night.

First we lost the European supplies, then the Malay States, Java and Batavia fell. Desperate efforts were made to build up domestic production and to develop sources in other fortunate countries which were not ravaged by war. Some tapioca was grown and ground in Brazil, and imports into the United States and Canada in 1944 and 1945 reached sizeable figures but did not amount to more than a small percentage of the former imports from the Netherlands East Indies. Also the quality was variable and generally inferior. Furthermore, in the United States the sale and use of tapioca and its derivatives were restricted by a conservation order, which, in effect prohibited its use in textile finishing.

The shortage was offset largely by the change from civilian to military fabrics, and emphasis in the starch picture was placed on supplying the greige mills which need starch for warp sizing. Fabrics finished for civilian use dropped to about 15 per cent of normal.

Large Demand for Materials

Now our finishing plants are converting to normal practice and a tremendous demand has arisen for starches, dextrines, gums, etc. This demand exceeds the supply, but prospects are good that the large grain crops will increase the supply. Until a settlement of the situation in Java is reached, little if anything can be learned as to when tapioca will be available in quantity.

Sago flour is now available from the Malay States. This is being used largely by the carpet trade, for back sizing, since Sago's tough, flexible film adheres well to jute yarns, and the impurities usually present in Sago flour do not cause any trouble in this type of work.

Corn starches and dextrines, scarce since the first of the year, should be in better supply. Wheat, which can often substitute for corn, is in short supply.

Uses for Starch

There are a number of fabrics on which permanent finishes are neither necessary nor desirable. On these fabrics a judicious combination of starches, dextrines, etc., will give the stiffness, crispness or appearance desired. Some starch base products applied to fabrics, assist in the physical changes achieved by the use of calenders or other types of mechanical finishing equipment. Some types of fabrics, such as linings for shoes, hats, etc., need to be quite stiff, but are not subjected to treatment which could remove a soluble or wash removable finish. The addition of 1 to 2 per cent starch to sheeting gives a slight crispness and a smoother mechanical finish. There are many more examples.

In general, starches and their derivatives will continue to be used for a large part of our future finishes, if for no other reason than that price will continue to be an all-important factor. Permanent finishes will continue to be relatively expensive, due in large part to the cost of the supervision necessary for controlling their application and fixation.

The good old days of the finishers' own type of magic being the determining factor in the results obtained are gone forever, and must be superseded by a much more exacting procedure in the controls of new products and processes.

The cooperation between the technicians of the finishing plants and those of the supply houses increased tremendously during the war, when we were all working for a common cause. It must continue for there remain many problems to solve, and we know now that neither side of the picture is complete without the other.

Fully Shrunk Spun Rayon Fabrics*

E. KORNREICH, F.T.I.

THE trend in modern textile finishing practice is towards stability of fabrics. The words "fast" and "proof" have become prominently associated with all properties exhibited by a finished textile article, and with the exterior forces influencing these properties. Fast-to-light, fast-to-washing, waterproof, creaseproof, mothproof, weatherproof, to name a few examples, have become standard words in the vocabulary of the textile finisher. One of the later additions is "shrink-proof," i.e. the achievement of dimensional stability. This problem was one of the most difficult to solve because its solution depended on the understanding of the fundamental structure of fibers. Science has gone a long way towards elucidating fiber structure and the efforts to obtain dimensional stability have achieved considerable success.

On treatment with hot aqueous liquors all fibers shrink to a greater or lesser degree. Owing to their peculiar molecular structure, wool and cotton, for instance, shrink gradually on successive wet treatments. To eliminate this undesirable property the application of drastic treatments has been found essential. For wool the problem was solved by chemical interference (predominantly chlorination), and for cotton a mechanical way has been found in "Sanforizing."

Spun rayon, however, differs with regard to its shrinking properties from other fibers. It is able to shrink fully of its own accord if allowed to contract freely during wet treatments and on drying. On using this inherent property of the fiber one can get a shrink-proof effect without any chemical or mechanical interference. This behavior is probably due to the much enhanced mobility of the cellulose molecule in rayon which gives the fiber an increased tendency to swell and thus to contract.

With this easy achievement of a shrink-

* Reprinted from the Textile Manufacturer, England.

proof effect another very desirable property goes hand in hand. When spun rayon (and this applies to all rayons in general) is stretched during drying, a harsh and glossy fiber results, but if allowed to shrink freely, the handle becomes mellow and the fabric assumes a particularly pleasing and dull appearance.

In order to achieve a satisfactory dimensional stability in spun rayon fabrics, however, several factors have to be taken into account. It has already been said that the fabric shrinks freely of its own accord when treated in a tensionless state with boiling aqueous liquors. Further contraction takes place on drying which to a large extent turns out to be a temporary one. This phenomenon, again a consequence of the enhanced mobility of the cellulose molecule in rayon, must be taken into account when producing fully shrunk rayon fabrics. The following will illustrate the point.

Shrinkage Experiments

From a spun rayon fabric which has been dyed and finished to full shrinkage, a small cutting of measured dimensions is again treated with boiling water. The surplus liquor is carefully squeezed out between layers of filter paper and the cutting left to dry at room temperature whilst lying flat on a glass plate. On checking up the dimensions one finds an almost negligible amount of contraction. The piece is then further dried at 50° C. and finally at 100° C.; the dimensions alter considerably with increasing temperature. If the piece is now allowed to take up moisture from the atmosphere until equilibrium is reached, the original dimensions are almost completely restored. The corresponding figures are recorded in Table I.

TABLE I

	Shrinkage, %	
	Warp	*Weft*
Room temperature	1.4	—
50° C.	5.7	3.3
100° C.	7.1	6.6
After 18 hours regain.....	2.9	0.5

The original dimensions from which the shrinkages are calculated are those measured in the wet state after squeezing between filter paper.

Restoration of the original dimensions on regain is the more remarkable insofar that the fabric, by lying flat on the glass plate, is restricted in its mobility by friction. If this is eliminated the result becomes even more striking. A narrow strip of the fabric (1 in. wide) is clamped on one side to a fixed point, on the other end to a movable indicator in such a way that an attached weight balances the weight of the fabric and just keeps it in position. The strip is supported by a wire netting with a suitable heating arrangement underneath. In order to be able to follow the changes in the moisture content the fabric is dyed with a dyestuff sensitive to moisture, so that any change in the moisture content is indicated by a color change. The fully shrunk fabric is clamped in wet, and then gradually dried. The indicator does not move until a point is reached at which the color change indicates the beginning of the removal of the last traces of moisture. Considerable contraction takes place which stops with the elimination of all moisture. On cooling and uptake of humidity the previous dimensions are restored after some time.

From these observations the following can be deduced: A spun rayon fabric is fully shrunk when allowed to contract freely during treatment with boiling aqueous liquors, say during scouring and dyeing. The further contraction observed during hot air drying is only a temporary one and need not be taken into account for full shrinkage, if calculated from the grey dimensions of the fabric. This temporary contraction may, however, have a considerable bearing on the successful shrinking of extended spun rayon fabrics. Further it follows that the contraction during hot air drying goes hand-in-hand with the removal of the last traces of moisture, i.e. the moisture which the fiber holds absorbed when in equilibrium with the humidity of its surroundings.

It will also be seen from these considerations that the dimensions of a shrunk spun rayon fabric will depend on its moisture content and therefore on the humidity content of its surroundings. Such changes in dimensions will become particularly apparent if the fabric is subjected to tension, even if only through its own weight. This phenomenon raised an additional problem to the achievement of dimensional stability. It is obvious that a fabric which extends on use, after having been fully shrunk, will be equally unsatisfactory. Though this problem is not so great as the one of satisfactory shrink-proofness, and although the danger of extension can be ignored in most cases, the difficulty can be overcome by restricting the moisture uptake of the fiber, in other words making it "moistproof." The well-known crease-resist treatments act in this direction. A fabric of most satisfactory dimensional stability will consequently be one that has been fully shrunk and resin treated.

It may be appropriate at this stage to mention that it has been claimed that the crease-resist process produces a shrink-proof fabric. It has been established since, that this is only the case if the tendency of the fabric to contract freely has been satisfied to a large extent. If this is not done the fabric will become unstable after consecutive washings through gradual removal of the resin.

"Wet" Tension

Another factor influencing final dimensional stability is the tension applied during wet treatments either during or prior to dyeing and finishing. Tension, when applied during dyeing and finishing, can interfere with the natural shrinking properties of spun rayon fabrics. In practice it is extremely difficult to completely eliminate tension. Winch dyeing, hydro-extracting, etc., exert a certain pull, but not sufficient to impair full shrinkage if handled carefully. Once the fabric has been extended, say by dyeing on a jig, it behaves rather like cotton, and successive treatments at the boil alternating with drying, both in the tensionless state, are necessary to achieve full contraction. The supercontraction on hot air drying, as mentioned above, comes in useful in this case.

Tension prior to dyeing and finishing is also a serious matter. If a fabric shrinks 15 per cent on complete contraction, one can reckon that on an average 5 per cent is due to tensions applied during sizing and weaving. As long as such tension has been acting in a regular manner, the final result will not be greatly affected. Great variations from piece to piece have, however, been observed and this may seriously affect not only the evenness of the finish but also the balance of the cloth. Shrinkage of a fabric is calculated on the length of the material in the loom state. Any variations can therefore lead to losses in cloth (D & K) to the detriment of the finisher. All this makes tension control prior to dyeing and finishing imperative, a factor which so far has not been sufficiently appreciated.

Finally we must consider the question as to what can be regarded as the optimum shrinkage of a particular fabric. The question must be answered for each type of fabric individually. The total contraction depends upon twist in the component yarns, the weave, grey width, and other factors. Of these most will be constant throughout a particular fabric, but grey width is known to vary considerably from piece to piece and such variations have an influence on shrinkage. All fabrics are finished to a certain width; width and length are interdependent. Pieces varying in grey width will therefore end up in finishing with various shrinkages in length—the fabric wider in grey incurring less loss in length.

The next factor determining the optimum shrinkage is the ultimate use of the fabric. For instance, a dress material will require just sufficient shrinking to prevent contraction during laundering.

Overshrunk dress goods have a tendency to extend, especially those of the heavier type. Overshrinkage matters less with lingerie fabrics, the enhanced handle and appearance may even be of benefit. Furnishing fabrics need rather less shrinking especially if used for curtain material. Here the moisture in the atmosphere will exert its influence, and the weight of the fabric will tend to lengthen the material.

It follows from the above considerations that no hard and fast rules can be established for fully shrunk fabrics, but the knowledge of the fundamentals will facilitate decisions.

The Dyeing of Direct Dyes on Cotton*

D. R. LEMIN, E. J. VICKERS and T. VICKERSTAFF

(Concluded from last issue)

THE combinations examined were divided into two classes. Class A combinations were those in which it should be possible to predict the course of dyeing without any ambiguity and included the following cases—

(1) Similar values of equilibrium exhaustion, or time of half-dyeing or both.

(2) Different values for both functions, but such that the differences reinforced one another.

(3) Compensatory types as in Class B, but such that differences in the values for one function obviously predominate, as in the following example—

	Equilibrium Exhaustion (%)	*Time of Half-dyeing (min.)*
Durazol Fast Violet 2BS....	17	1.9
Chlorazol Green BN125.....	86	4.0

The difference between the values for equilibrium exhaustion is so great that the course the dyeing process should take is obvious.

Class B contained all the combinations not mentioned above, the largest number being those in which the differences in equilibrium exhaustions and times of half-dyeing were compensatory.

The assessment of the predictability of the course of the dyeing process for Classes A and B is given for both observers combined in Table VIII. Borderline cases are taken to include all those where there was not perfect agreement between the two observers concerning the compatibility or otherwise of any combinations.

The results for the two observers and for both combined differ mainly in the number of borderline cases, and the differences have arisen from the difficulty in assessing such cases.

TABLE VIII

	Class A (194 Combinations)	Class B (113 Combinations)	Total (307 Combinations)
Prediction justified (%) ...	67	49	60
Prediction not justified (%)	17	27	21
Borderline (%)	16	24	19

Considering only Class A combinations, where prediction may be made without ambiguity, in the final analysis approximately two out of every three definitely follow the expected course, while one in six is wrong. In Class B the final analysis shows that the proportion of predictions justified is lower at 1 : 1, thereby demonstrating that it is more difficult to predict the course of the dyeing process when there are differences in both the equilibrium values and times of half-dyeing which tend to compensate one another.

The implication of these results should be carefully considered. So far attention has not been confined to the prediction of compatibility, but has included a majority of cases where one dye may be expected to dye first. It may be anticipated that it will be more difficult to predict the compatibility of dyes than merely to predict which dye will be absorbed the more rapidly. The results so far described show only that with Class A combinations in two cases out of three the course of the dyeing process may be predicted correctly, and that with Class B combinations only 50 per cent of the predictions are justified.

The results, therefore, have been further analyzed to include the prediction of compatibility, and the conclusions arising from this further analysis may be summarized as follows. Of 46 Class A combinations predicted as fairly compatible or borderline, 23 (50 per cent) were found to be so. In addition to these, some combinations were found to be compatible, although they had not been so predicted. Thus, out of 39 compatible or fairly compatible combinations only 23 (59 per cent) had been so predicted. It may be shown similarly that for Class B combinations, the chances of predicting compatibility are somewhat less at about 1 in 3, for the prediction of compatibility is more difficult owing to compensation in the values for equilibrium exhaustion and time of half-dyeing. Finally, it is interesting to note the proportion of non-compatible combinations which have been so predicted. The figures are—Class A, 89 per cent; Class B, 88 per cent; total, 89 per cent. This confirms what has already been stated, viz. that it is much easier to predict non-compatibility than compatibility.

A more detailed analysis of the results indicated that certain dyes were outstanding in giving a very high proportion of results which were contrary to the predictions from the rate-of-dyeing data. In these cases the rate data were checked, since any error could obviously produce such an effect, but the new measurements revealed no serious discrepancies, although in the case of Chlorazol Yellow 6GS (which of all the dyes exhibits the least agreement between dip tests and predictions) the shape of the dyeing curve was found to be abnormal. Ignoring this dye, however, it may be observed that Chlorazol Green BN 125 and Chlorazol Dark Green PL 125 show a marked tendency to dye first, and Chlorazol Fast Pink BK 200, Chlorazol Fast Helio 2RK 200 and Chlorazol Sky Blue GW 400 a marked tendency to dye last, irrespective of the rate-of-dyeing constants of the dyes with which they are mixed. Certain other dyes also show similar tendencies to a lesser extent.

Direct Dyes on Viscose Rayon

The obvious corollary to the above

* Reprinted from the Journal of the Society of Dyers and Colourists, May, 1946.

work on the compatibility of direct dyes on cotton was to test the validity of Boulton's table[3], in order to ascertain how far this affords a guide to dyeing properties on viscose rayon.

To this end 71 combinations were dyed on viscose rayon satin* under conditions as near as possible to those employed by Boulton, except, of course, that the salt concentration had to be maintained constant throughout. An addition of 10 per cent calcined Glauber's salt was taken as representing an average value from the point of view of practical dyeing conditions, and 0.5 per cent shades of standard dyes were used, with a 40 : 1 liquor-goods ratio; otherwise, the method of test was as employed in the determinations on cotton. Shade combinations were chosen much as before, i.e. of primary or complementary colors. In addition, one brown (Chlorazol Brown MS) was included and dyed in combination with greens, yellows and blues. The red-shade violet, Chlorazol Fast Helio 2RKS, was also dyed with four blues and the brown.

Prediction of the course of dyeing was much easier here, since only one variable, viz. time of half-dyeing, has to be taken into consideration (Table IX).

TABLE IX
Prediction of Dyeing Behaviour on Viscose Rayon Satin

Total of Combinations	Course of Dyeing		
	Right	Borderline	Wrong
71	29 (41%)	5 (7%)	37 (52%)

The chances of a correct prediction of the course of dyeing appear as before to be not greater than one in two, which includes the borderline cases.

If attention is confined to the prediction of compatability, the results of Table X are obtained.

TABLE X
Compatibility on Viscose Rayon Satin

Predicted as Compatible	Found Compatible	Borderline Cases	Found not Compatible
19 combinations	4 (21%)	4 (21%)	11 (58%)

Including borderline cases, the chances of predicting compatibility appear to be about two in five, although it must be realized that the number of combinations here is rather small for this to be represented as an accurate analysis.

In addition to the above, 11 combinations were found to be compatible or borderline which were not predicted as such. The times of half-dyeing of the dyes in these mixtures are widely different, and in view of their interest they are given in detail in Table XI.

In addition, it was again observed that several dyes showed a tendency to dye first or last irrespective of the rate of dyeing of the second component, and in many cases this means that a rapid dyeing dye may go on to the fiber after the slower-dyeing component. Some outstanding examples of this reversal of dyeing rates in mixtures are given in Table XII.

TABLE XI
Half-dyeing Times (Boulton) of Compatible Combinations on Viscose Rayon Satin

Combination	Half-dyeing Time (min.)
Chlorazol Steel Blue 6BS	18·2
Durazol Fast Orange 2GS	155·5
Chlorazol Blue GS	8·4
Chlorazol Fast Pink BKS	280·0
Chlorazol Blue GS	8·4
Durazol Fast Orange 2GS	155·5
Durazol Helio BS	1·2
Chlorazol Green GS	27·7
Chlorazol Fast Yellow 5GKS	1·1
Chlorazol Brown MS	21·0
Durazol Red 2BS	0·84
Chlorazol Dark Blue BS	16·70
Durazol Red 2BS	0·84
Durazol Fast Blue 3RS	24·1
Chrysophenine GS	0·26
Chlorazol Fast Scarlet GS	33·2
Chlorazol Fast Helio 2RKS	0·18
Chlorazol Steel Blue 6BS	18·2
Chlorazol Fast Helio 2RKS	0·18
Chlorazol Dark Blue BS	16·7
Chlorazol Fast Helio 2RKS	0·18
Durazol Fast Blue 3RS	24·1

In all the above analyses the amount of salt added by Boulton to bring the equilibrium exhaustion to 50 per cent approx. has been ignored. Taking into account this factor in addition to time of half-dyeing, the number of predicted compatible combinations falls to 8, of which 2 (25 per cent) were found compatible, 2 (25 per cent) were found borderline cases and 4 (50 per cent) were found not compatible. Thus, there is very little difference in the actual results, although the number of examples examined is now very small.

Summarizing these results, it appears that the chances of predicting compatibility on cellulosic fibers from rate-of-dyeing data are not greater than about 1 in 2 in all cases. In addition, if attention is confined to those combinations predicted as compatible on the basis of the rate-of-dyeing data, then a large number of possibly useful combinations not so predicted will have been overlooked. This conclusion is so important and so contrary to the general estimate of the value of rate-of-dyeing data that it is desirable to review briefly the various factors upon which the conclusion is based, in order to gain some opinion as to its validity.

The first factor is obviously the accuracy and reproducibility of the data. This matter has already been discussed and an estimate of the accuracy obtained, and in addition the data on a number of the dyes have been re-determined without noticeably modifying the results, but it should perhaps be noted that the conditions of dyeing used in the dip test were not quite the same as those used for the measurement, particularly as regards the lack of mechanical circulation of the dye-liquor. However, if this is really the cause of the discrepancy, then it may be anticipated that similar, but very much greater, effects will be shown in any attempt to predict full-scale compatibility from laboratory trials. Further, in many cases of non-agreement with dip tests, the measurements in the two extreme liquor lengths gave the same indication as to compatibility. It seems, therefore, that this aspect of the question cannot seriously influence the conclusion as to the value of the data, for the reproducibility under the specified conditions is fairly high, while, if the results are greatly affected by dyeing conditions, the prediction of full-scale compatibility from laboratory dyeing measurements is impossible.

The second factor to be considered is the arbitrary limit for differences in rate of dyeing which have been chosen as a criterion of compatibility. If the limits were made wider, then more combinations would be predicted as being compatible, but examination of this possibility indicates that the additional number of combinations predicted as compatible, and actually found to be so, would be outbalanced by the number not found to be compatible. Restriction of the criteria of compatibility to still narrower limits would increase the number of combinations found to be compatible, but not so predicted.

Thirdly, very careful consideration must be given to the method actually used for estimating practical compatibility in rate of absorption, viz. the dip test. It may be argued that this test is much too critical and that many combinations found to be incompatible by this test may work well together in practice. Thus, many combinations predicted as compatible and found on this test not to be so, may yet be satisfactory in practice, so that dyeing-rate measurements may be a guide to practical

TABLE XII
Anomalous Behaviour on Viscose Rayon Satin

Component Dyeing First	Time of Half-dyeing	Component Left Behind	Time of Half-dyeing	Remarks
Chlorazol Fast Scarlet 8B 125 ...	43·8	Chlorazol Blue G 150	8·40	Effect very marked
Chlorazol Dark Green PL 125 ...	4·5	Durazol Red 2BS	0·84	—
Chlorazol Dark Green PL 125 ...	4·5	Chlorazol Violet N 125	0·50	Effect very marked
Chlorazol Dark Green PL 125 ...	4·5	Durazol Helio B 200	1·20	—
Chlorazol Dark Green PL 125 ...	4·5	Chlorazol Fast Helio 2RK 200 ...	0·18	Effect very marked
Chlorazol Green GS	27·7	Durazol Red 2B 150	0·84	—
Chlorazol Green GS	27·7	Chlorazol Violet N 125	0·50	Effect very marked
Chlorazol Green GS	27·7	Chlorazol Fast Helio 2RK 200 ...	0·18	—
Chlorazol Fast Yellow 5GKS ...	1·1	Chlorazol Fast Helio 2RK 200 ...	0·18	Effect very marked
Chlorazol Fast Yellow 5GKS ...	1·1	Chlorazol Violet N 125	0·50	Effect very marked
Durazol Helio B 200	1·2	Chrysophenine G 200	0·26	Effect very marked
Chlorazol Brown M 150	21·0	Chrysophenine G 200	0·26	Effect very marked
Chlorazol Brown M 150	21·0	Chlorazol Fast Helio 2RK 200 ...	0·18	Effect very marked
Chlorazol Brown M 150	21·0	Chlorazol Blue G 150	8·40	Effect very marked
Chlorazol Brown M 150	21·0	Chlorazol Dark Green PL 125 ...	4·50	—
Chlorazol Fast Scarlet GS	33·2	Chlorazol Blue G 200	8·40	Effect very marked

* This material was woven from continuous filament viscose rayon in a 3/1 weave, using, per in., 110 threads of 64/17 yarn and 64 picks of 142/36 yarn.

compatibility. This, however, cannot explain the number of combinations found to be compatible and not so predicted. That these combinations do actually dye satisfactorily in practice has been shown by carrying out full-scale winch dyeings on viscose rayon piece with the eleven combinations detailed in Table XII. The dyebath was set without salt and additions of salt were made gradually during dyeing. Samples were taken from the piece at intervals to see how the shade built up. In nearly all cases the color was found to build up on tone from the beginning to the end of the dyeing operation, thus supporting the result obtained in the dip test. In the three cases where the shade did not remain perfectly on tone, the deviation was very small. These trials show conclusively that mixtures found compatible by the dip test are compatible under practical conditions, so that the dip test is a reliable guide in this respect at least.

Further, the argument that the dip test is over-critical as compared with practice, implies that in full-scale working, aspects of dyeing behavior other than the actual rate of absorption of the dyes are of importance, and if the argument is further developed to the point that individual dyeing rates are a guide to practical compatibility, although not to behavior in a dip test, then dyeing rate is being used not for its intrinsic value, but as a guide to other dyeing properties. This argument is discussed in more detail later.

To sum up the situation, it may be stated that examination of the various aspects does not indicate that there is any real reason to dispute the validity of the conclusion that *the compatibility of direct dyes on cellulose as regards the rate of dyeing cannot be predicted from individual rate measurements with a greater degree of sucess than* 1 *in* 2, and that such methods of selecting dyes for mixtures will lead to the neglect of many possible useful combinations of dyes which dye at similar rates in binary mixtures.

Rate of Dyeing as an Indication of the Practical Behavior of Single Dyes

From the foregoing it appears that the individual rates of dyeing are of little use for predicting compatibility in dyeing, but the possibility remains that the information may be of value as a guide to practical behavior in those cases when mixtures are not involved. This naturally is of more limited interest since the greater part of dyeing involves mixture shades. This use of rate-of-dyeing data has not been investigated in the present work because of its limited value, and also because the wide variations in rate observed in the laboratory with comparatively minor changes in dyeing method indicate that the possibility of applying the small laboratory-scale dyeing results to a full-scale machine, with any degree of success, is remote. Liquor length and temperature changes, and variations in concentration and rate of circulation, all combine to alter the rates beyond any hope of prediction, for, unfortunately, it does not seem that all dyes are affected to the same extent by these changes, so that dyes arranged in an order of rate under one specific set of conditions will not necessarily fall in the same order under other conditions.

Rate of Dyeing as a Guide to General Dyeing Properties

A further use of rate-of-dyeing data, which has not so far been considered, is as a guide to the general dyeing properties of a dye. This has been particularly studied by Boulton on the assumption that if dyeing rate is measured under conditions of nearly constant dyebath concentration (i.e. sufficient salt to produce half exhaustion), then it is a measure of particle size, and hence will be a guide to the levelling properties of dyes. This assumption can only be applied to the rates measured under Boulton's specific conditions and not to rates measured under dyebath conditions leading to a high degree of exhaustion, but even under favorable conditions it is doubtful whether such a measurement can be more than a rough guide to the levelling properties. It seems much more desirable to measure levelling directly rather than to derive it from dyeing rate, and in the present work such measurements have been made in a manner which are described later. When the dyes were placed in order of levelling power on cotton it was noted that this order was not the same as the order of dyeing rate as determined by Boulton on viscose rayon. The difference in fiber may well produce profound effects, but it was thought worth while to carry out a few tests to discover whether the difference was due solely to the fiber. Accordingly, a number of pairs of dyes were dyed on both cotton limbric and viscose rayon satin. Samples of the dyeings were then boiled with undyed material in blank dyebaths containing 20 per cent calcined Glauber's salt and cuttings taken from both dyed and undyed materials at intervals. In most cases it was easy to see which dye migrated to the undyed material first. The results are given in Table XIII.

In the second column of Table XIII is given the time of half-dyeing as determined by Boulton, and in the next column the dye migrating first on the viscose rayon. Then follows the time of half-migration on cotton as determined by the method described later in this paper, and finally the dye migrating first on cotton. It will be seen that in all four mixtures examined the observed migration behavior on cotton agrees with that to be expected from the time of half-migration. The observed behavior on the viscose rayon does not agree with the half-dyeing times of Boulton in the last two cases, and even in the case of the Durazol Helio B 200 and Chlorazol Dark Green PL 125 mixture, the separation of the two components is much greater than would be anticipated. The number of combinations examined is small, but further evidence is to be found in a recent paper by Boulton[3] where the levelling properties of dyes are compared with their half-dyeing times. To take a few examples from Table IV of that paper[3], Chlorantine Fast Green 5GLL (Ciba), having a half-dyeing time of 2.4 min. requires 2.5 hr. to level, and Chloramine Brilliant Rose B (S.) with a half-dyeing time of 1.7 min. is not level in 3 hr. These dyes may be compared with Solophenyl Red Brown (Gy.) which is level in 2 hr., but has a half-dyeing time of 18.3 min., Chlorazol Fast Blue 2BNS which is level in 2 hr., but has a half-dyeing time of 18.3 min., and Chlorazol Fast Blue 2BNS which is level in 3 hr., but has a half-dyeing time of 24.1 min. From all these results it must be concluded that rate of dyeing, even under conditions of low exhaustion, is not a fully reliable guide to practical rate of migration, which is better measured directly.

TABLE XIII

Combination	Viscose Rayon		Cotton	
	$t_{\frac{1}{2}}$ (Boulton)	Dye Migrating First	$t_{\frac{1}{2}}$ (migration)	Dye Migrating First
Chlorazol Blue B 200	18·3	Together	9	Blue
Chlorazol Brown M 150	21·0		74	
Durazol Helio B 200	1·2	Helio	8	Helio
Chlorazol Dark Green PL 125	4·5		49	
Durazol Fast Blue 3R 200	24·1	Blue	16	Blue
Chlorazol Brown M 150	21·0		74	
Chlorazol Dark Green PL 125	4·5	Together	49	Together
Chlorazol Fast Orange R 150	40·8		59	

The Value of Rate-of-dyeing Data

From the foregoing argument it may be concluded that *rate-of-dyeing measurements on cellulose of individual direct dyes are of little value in predicting compatible combinations of dyes*, and are not a reliable guide to the behavior of single dyes in full-scale machines or to their general dyeing properties. This applies both to rates measured under practical conditions and to rates measured under conditions producing only partial ex-

haustion of the dyebath. It is therefore desirable to have some other guide to the dyeing behavior of direct dyes on cotton.

Before proceeding to discuss alternative methods, however, it may be helpful to consider briefly the reasons for the failure of rate-of-dyeing measurements. Fundamentally, the failure is due to the fact that dyeing rate is not in itself a single simple function, but is a combination of two things, viz. rate of diffusion of dye inside the fiber and the chemical affinity of the dye for the fiber. This view has, of course, been expressed by previous workers, but the implications appear to have been neglected. The dyeing of cellulose fibers may be pictured in the following way—

On placing the fiber in the dyebath, dye is absorbed extremely rapidly on the outer surface or skin of each individual filament and equilibrium between this skin and the dyebath is quickly established. After this initial stage, no more dye can enter the fiber, except through the surface layer, and consequently, the overall rate of dyeing is governed by the speed at which dye leaves the surface layer and penetrates to the inside of the filament. Any space left on the surface by such a movement is immediately filled from the dyebath. The process by which dyeing proceeds along the inter-micellar canals of the cellulose fiber is most probably a step-wise diffusion along the surface, i.e. the dye becomes attached to the cellulose and remains there until by thermal agitation or by impact it is displaced, when it wanders down the canal until it is again caught and attached to the wall. Clearly the speed of penetration is governed firstly by the speed with which the dye diffuses in solution, which is mainly a function of particle size. Secondly, the speed will depend on the strength of the forces attaching the dye to the cellulose, viz. on the chemical affinity. The firmer the attachment, the less frequently will the dye be dislodged from the canal wall and the more slowly will it penetrate towards the center of the fiber. There is also another effect of affinity which acts in opposition to the first effect, for a dye of high affinity will build up to a greater concentration in the surface layer than a dye of lower affinity, and this results in a greater concentration gradient from the outside to the inside of the fiber, leading to a slightly increased rate of penetration of the filaments. This effect is secondary, however, and, in general, the higher the chemical affinity, the slower the rate of dyeing. This may seem contradictory to the practical dyer, who uses the word affinity in a rather loose sense to cover such things as rate of exhaustion, final exhaustion and saturation value.

The rate of dyeing under practical conditions is thus a reflection of both these factors, and an example will make it plain how anomalous behavior in mixtures can arise. Suppose that a dye A has a high rate of dyeing and that this is due to small particle size and fairly low affinity, whilst dye B is slow dyeing and this is due primarily to high affinity. When the two dyes are mixed, the individual rate measurements would lead to the prediction that dye A would go on the fiber first, but in fact both dyes compete for the fiber skin and dye B having the higher affinity occupies it almost completely. Thus, the only dye which can penetrate into the fiber is B, which therefore disappears from the dyebath first in spite of its slower dyeing rate.

The same observations apply also to dyeing-rate determinations made under conditions of low exhaustion, for, although such measurements are primarily of particle size, the quantity of salt present is variable and represents an indirect measure of affinity which is ignored in choosing compatible dyes.

This duality of dyeing rate accounts for many of the discrepancies between observed and predicted behavior in mixtures, although it is probable that there are still other factors to be considered. In some cases, although exhaustion and rate of dyeing of the two dyes are both identical, anomalies still occur, possibly owing to differing salt sensitivity.

Alternatives to Dyeing Rate

If the dyeing rate of direct dyes is of little value to the practical dyer, how else can he be assisted in the choice and use of dyes? It seems to the present authors that the most useful assistance which can be given is the arrangement of the dyes into three or four groups depending upon their dyeing behavior, and the most satisfactory classification appears to be that suggested by Whittaker[2], suitably modified to avoid the use of rate-of-dyeing data. Whittaker, in his description of the groups, uses rate of dyeing (measured by Boulton's method), but examination shows that this is not really necessary and is, in fact undesirable. In the modified classification here suggested, the levelling power of direct dyes is considered to be of prime importance; consequently, all direct dyes can be divided into two broad classes, viz. those which level or migrate well and those which do not. The first group (Class A according to Whittaker) may dye unevenly at first, but soon level out, so that they are the easiest dyes to apply and require no special treatment. The dyes which do not migrate well must be applied with care and, if possible, the degree of exhaustion must be increased slowly and uniformly over the whole course of dyeing, so that the dyeing is even and little or no levelling is required. Some dyes, in the absence of salt, exhaust only poorly from the dyebath, but the exhaustion can be increased by the gradual addition of salt. Such dyes, of poor levelling power, but susceptible to control by salt addition, form Class B of Whittaker's classification. Finally, there remains a group of dyes which are also of poor levelling power and which exhaust well in the absence of added salt. In such cases control by salt is not possible, and the only way of slowing down the dyeing process, so as to obtain uniform and gradual absorption of the dye, is by starting at a low temperature and raising the temperature gradually so that the initial absorption of dye is retarded. This group of dyes forms Whittaker's Class C. In Whittaker's classification there is no need to consider rate of dyeing at all and, indeed, it is not used by Whittaker in his scheme for its intrinsic value, but only as a guide to levelling power. It has already been pointed out that there is not a perfect correlation between time of half-dyeing (Boulton) and levelling, so that this use of rate-of-dyeing data seems undesirable. Thus, Viscose Navy Blue NB (C.N.), for example, is placed in Class A by Whittaker because of its rapid dyeing rate (half-dyeing time 3.2 min.), but Boulton[3] (in his Table IV, p. 10) shows that its levelling power in both water and salt solution is extremely poor and similar to that of Diphenyl Fast Blue Green BL (Gy.) (half-dyeing time 159 min.—the slowest in the Table). According to the classification now suggested, this dye would go into Class C containing dyes of poor levelling power and exhaustion not controllable by salt.

This modification of Whittaker's scheme is only of a minor nature and the classification as a whole appears to be extremely valuable to the practical dyer, since it provides a good indication of the type of behavior to be expected in practice and the dyeing technique necessary for the production of level dyeings.

Consequently, an attempt has been made to arrange direct dyes in three groups according to this scheme, which may be re-defined for convenience as follows—

Class A—dyes of high levelling power.

Class B—dyes of poor levelling power, exhaustion being controllable by salt additions.

Class C—dyes of poor levelling power, exhaustion being not controllable by salt additions.

Rate of Migration

The first sorting test required in order to place dyes in the appropriate groups

in the above classification is a measure of levelling power, and this should preferably be a direct measurement and not an inference from some other measurement. Accordingly, a method of examination was devised based upon the well-known test in which dyed and undyed materials are treated together in a blank dyebath and the rate of approach to a common depth of shade observed. In order to make the test more quantitative, the quantity of dye on the dyed and originally undyed material was estimated at intervals and the result expressed in terms of the time of half-migration. Several methods of carrying out the tests were tried, but most of them gave uneven dyeings on the undyed material after short time intervals. The method finally adopted, which gives fairly satisfactory results, is described later.

TABLE XIV
Cotton Limbric: Rate-of-migration Experiments

Dye	Time (min.)	Dye on Originally Dyed Material (%)	Dye on Originally Undyed Material (%)
0·5% Chrysophenine G 200...	0	0·188	0·000
	2	0·095	0·011
	4	0·073	0·018
	8	0·058	0·023
	16	0·050	0·032
	32	0·044	0·036
	64	0·039	0·035
0·5% Chlorazol Sky Blue FF 200	0	0·410	0·000
	4	0·281	0·023
	8	0·291	0·040
	16	0·222	0·074
	32	0·190	0·106
	64	0·170	0·128
	128	0·159	0·148
0·5% Chlorazol Orange PO 150	0	0·366	0·000
	4	0·252	0·018
	8	0·208	0·044
	16	0·170	0·078
	32	0·155	0·095
	64	0·138	0·116
	128	0·137	0·123

Times of Half-migration obtained Graphically (min.)—
Chrysophenine G 200 ... ... 4·5
Chlorazol Sky Blue FF 200... ... 17
Chlorazol Orange PO 150 14

In order to investigate the process of levelling in detail, three dyeings were subject to close examination and determinations were made at a number of times. The results are given in Table XIV, illustrated by Fig. 11. The time of half-migration was determined graphically from the results of the originally undyed material. This function is defined for the purpose of the present work as the time required in this test for undyed material to become dyed to half that depth of shade to which both pieces of material are tending. This final shade will not be equal to half the depth of shade on the original dyed cloth, for a considerable amount of dye is desorbed into the blank dyebath and remains there even at the end of the experiment. This constitutes a definite defect in the method of testing here adopted and, although it is considered that it will not materially affect the results, it is suggested that a better method, yielding results in closer accord with levelling occurring in practice, would be to dye a piece of material in a normal bath and, after equilibrium

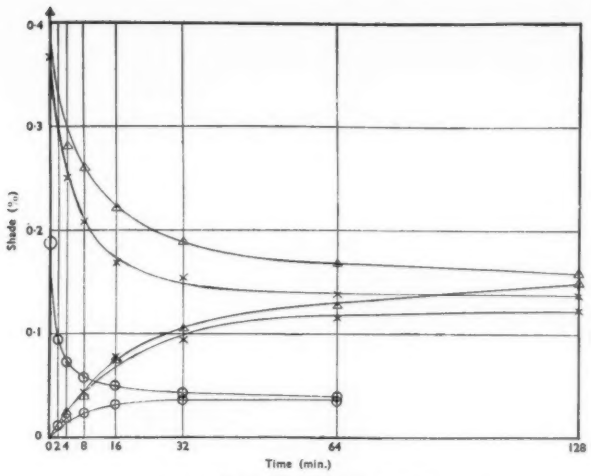

FIG. 11—Rate-of-migration Curves in 60 Vol.
—O— Chrysophenine G 200 —△— Chlorazol Sky Blue FF 200
—×— Chlorazol Orange PO 150

has been attained, to remove half the material, replace it with undyed material and measure the rate of levelling from that point. Such a technique would avoid the initial phase in the present method when dye is desorbing from the dyed material into the dyebath and is not appreciably dyeing the undyed material.

However, this technique was not used in the work under discussion and all results have been obtained in the manner already described, viz. by placing dyed and undyed material together in a blank dyebath containing no dye.

The amount of work involved in determining a complete desorption curve on both materials (as shown in Fig. 11) is very considerable, so a method was sought whereby the labor involved could be reduced.

From the above results it was found that when the reciprocal of the time was plotted against the reciprocal of the amount of dye on the undyed material, the points lay on an approximately straight line in each case, thus showing that the absorption curves are hyperbolic in form. Therefore, if the equilibrium value and one point on the curve are known, it is possible to calculate the time of half-migration from the equation—

$$t_{1/2} = \frac{t}{x}(F - x)$$

(F = % dye on the material at equilibrium; $t_{1/2}$ = the time of half-migration; and x = % dye on the originally undyed material at time t).

Admittedly, this hyperbolic equation is only an approximate fit to the curve, but in view of the wide range of migration rates which was observed, it is considered that the error involved in using this formula is very small and amply compensated by the great reduction in experimental work required. The times of half-migration, therefore, were determined by performing three migration tests on each dye. One test was carried out for a prolonged period of time in order to determine the equilibrium value F. In most cases this value was taken as the average of the dye content of the two samples, since the two materials did not become perfectly identical, except in a few cases with the most rapid levelling dyes. Prolonged boiling is undesirable as the possibility of decomposition arises. In addition to this experiment to determine equilibrium value, two migration experiments for shorter periods were carried out, and in these only the amount of dye on the originally undyed material was determined. Substituting the values in the equation already given yielded two values of the time of half-migration, and the agreement between these indicated the reliability of the results. The duration of the shorter time tests was determined by the appearance of the fabric while in the blank dyebath, and experience showed that it was possible to select times in the neighborhood of the half-migration time, so that the error in calculation was small.

As an example, the complete results for Durazol Blue 2GN 200 are given in Table XV.

TABLE XV
Cotton Material: Migration Tests with 1% Durazol Blue 2GN 200

Time (min.)	Dye Remaining on Dyed Material (%)	Dye Transferred to Blank Material (%)
0	0·770	0·0
10·25	—	0·075
20	—	0·119
500	0·268	0·255

F = 0·261 (average of 0·255 and 0·268); $t_{\frac{1}{2}}$ (calc.) = 25·5 and 23·8 min., respectively; mean $t_{\frac{1}{2}}$ = 25 min.

Since the results obtained in this way apply only to the particular dye and Glauber's salt concentrations stated, some experiments were carried out to deter-

mine how the migration is affected by variation in these factors. In order to investigate the effect of dye concentration, migration tests were carried out on six dyes in five different depths of shade. The results are given in Table XVI.

TABLE XVI
Cotton Limbric: Effect of Dye Concentration on Rate of Migration

Dye	Percentage of Total Dye Transferred to Originally Undyed Material — Initial Shade of Dyed Material (%) —				
	0·25	0·5	1·0	2·0	4·0
Durazol Red 2B 150 ...	—	3·2	2·8	2·8	2·4
Durazol Fast Blue 4R 200	3·0	3·5	4·0	4·6	—
Durazol Fast Rubine B 150	—	17·5	12·6	12·0	7·8
Durazol Fast Blue G 200	—	16·4	15·7	11·0	8·8
Durazol Blue 2GN 200 ...	—	20·0	18·0	17·0	11·0
Chlorazol Black BH 150 ...	—	51·0	35·0	33·0	24·0

It is clear from TableXVI that the concentration of dye on the fiber does influence the rate of migration; in all cases except Durazol Fast Blue 4R 200 the heavier the shade, the more rapidly levelling takes place. The effect of concentration with Durazol Fast Blue 4R 200 is small. This increase in rate of migration is probably due mainly to the increased concentration of dye in the dyebath, but a contributory factor may be the penetration of the dye into the individual filaments. The dyeings were carried out for a normal dyeing time (1 hr.) and, possibly, the dye in the stronger shades may have failed to penetrate the filaments as completely as in the weaker shades, thus rendering it more loosely held closer to the surface of the filaments and hence more free to migrate. In order to ascertain whether this was the case, the tests on 0.5 per cent and 4 per cent Chlorazol Black BH150 were repeated on material dyed for 4.5 hr. instead of 1 hr. The half-migration times thus obtained were 64 min. for the 0.5 per cent shade and 34 min. for the 4 per cent shade. It appears that the time of dyeing, and hence the degree of penetration of the dye, does have some effect on the rate of migration, but this effect is of a similar order in the case of both weak and strong shades and does not appear to be responsible for the change in rate of migration with change in concentration of dye. The significance of this effect on the whole series must also be considered. In general, the effect will be to reduce the differences observable between dyes, for the rapid-levelling dyes will be well-penetrated and will thus have a slower relative rate of migration than would be the case if the dye was distributed through the fiber in the same way as a slower-levelling dye. Since it may reasonably be assumed that dyes which migrate most rapidly will be most uniformly distributed through the fiber, it is unlikely that the order of the dyes in Table XVI will be appreciably altered by this effect.

In order to investigate the effect of the concentration of salt in the dyebath on the rate of migration, the rate of migration of six dyes was observed in baths of varying salt content. In baths containing no salt at all, very erratic results were obtained and in some cases extremely long times of half-migration. In all cases very considerable bleeding of dye into the bath occurred, but there was little dyeing of the original uncolored material. The results are given in Table XVII.

TABLE XVII
Cotton Limbric: The Effect of Salt Concentration on Rate of Migration

Dye	Times of Half-migration (min.) — Calcined Glauber's Salt (%) —			
	10	20	40	50
1% Durazol Red 2B 150 ...	3	3	–	9
1% Durazol Fast Blue 4R 200 ...	3	4	–	8
1% Durazol Fast Rubine B 150 ...	8	12	–	17
1% Durazol Fast Blue G 200 ...	14	16	23	–
1% Durazol Blue 2GN 200 ...	11	18	–	32
0·5% Durazol Grey N 125 ...	19	24	27	–

In all cases an increase in the amount of salt in the dyebath slows down the rate of migration. This may be attributed to the fact that the presence of the salt reduces the concentration of dye actually in the dyeliquor, and it can be shown on theoretical grounds that the greater the amount of dye in the dyebath at equilibrium, the more easily will levelling occur. This is also in agreement with the observations on the effect of dye concentration on the fiber, and both effects must be borne in mind in any consideration of the migration data. The full results on all the dyes examined are given in Table XVIII, the experimental details being as follows—

Dyed cotton limbric (0.5 g.) is cut into small portions of distinctive shape, each piece being about 0.5 sq. cm., and mixed with an equal weight of uncolored material similarly cut into pieces of different shape. The combined materials are cast into a boiling solution of calcined Glauber's salt (60 c.c. containing 20 per cent of calcined Glauber's salt on the total weight of fabric), contained in a round-bottomed flask fitted with a reflux condenser. After boiling for a suitable length of time, the contents of the flask are drowned in cold water, the material separated, rinsed in water and dried on filter paper in an oven. The two parts of the sample are separated by hand, conditioned in air, weighed, and placed in large test-tubes in a boiling water-bath and covered with successive portions (10 c.c.) of 25 per cent aqueous pyridine until all the color is extracted. The combined extracts are made up to suitable volume with 25 per cent pyridine and the dye content estimated colorimetrically. Three such experiments are carried out, one for a period of 2 hr. and the other two experiments for shorter times approximating to the half-migration time. In the case of the more prolonged dyeing, the amount of dye on both originally dyed and undyed material is estimated and the mean value of the two results is taken as the final equilibrium value which would be attained when the two fabrics reached the same depth of shade. In the case of the less protracted dyeings, only the amount of dye on the originally uncolored material is estimated. The values so obtained are inserted in the hyperbola equation together with the equilibrium value to obtain two values of the time of half-migration.

TABLE XVIII
Rates of Migration of Direct Dyes on Cotton Limbric

Dye	Time of Half-migration (min.) (mean of at least two determinations)	Total Dye Remaining in Blank Dyebath (%)
1·0% Durazol Red 2B 150 ...	3	52
0·5% Durazol Fast Blue 4R 200 ...	4	53
0·5% Chrysophenine G 200 ...	4·5	60
1·0% Chlorazol Yellow 6GS ...	5	41
0·5% Durazol Helio B 200 ...	8	49
1·0% Durazol Grey RG 125 ...	8	52
1·0% Chlorazol Blue B 200 ...	9	42
1·0% Durazol Fast Violet 2BS ...	9	62
1·5% Chlorazol Catechine GR 150	9	51
1·0% Chlorazol Blue G 150 ...	10	52
0·5% Chlorazol Fast Helio 2BK 200	11	51
1·5% Durazol Fast Grey GS ...	13	59
1·0% Durazol Fast Rubine B 150	13	47
0·5% Chlorazol Orange FO 150 ...	14	30
2·0% Durazol Fast Blue 4GS ...	14	50
1·0% Durazol Fast Blue G 200 ...	16	44
1·0% Durazol Fast Blue 2R 200	16	41
1·0% Durazol Fast Blue 3R 200 ...	16	32
1·0% Durazol Fast Yellow 6GS ...	16	23
0·5% Chlorazol Sky Blue FF 200	17	24
0·5% Chlorazol Bordeaux 6B 150	17	25
1·0% Durazol Blue 2GN 200 ...	18	32
0·5% Chlorazol Sky Blue GW 400	20	29
1·5% Chlorazol Green GS ...	20	40
1·0% Chlorazol Fast Red F 125 ...	22	19
1·0% Durazol Fast Grey B 125 ...	22	29
1·5% Durazol Grey N 125 ...	24	26
1·0% Chlorazol Fast Scarlet 4BAS	25	31
1·0% Chlorazol Fast Scarlet 8B 125	28	31
0·5% Durazol Fast Orange 4R 150	29	37
0·5% Durazol Fast Yellow G 400	31	15
2·5% Chlorazol Black FB 150 ...	33	28
1·0% Durazol Fast Orange 2G 125	34	24
1·0% Chlorazol Black BH 200 ...	37	17
1·0% Chlorazol Fast Scarlet GS ...	38	30
2·0% Chlorazol Black FF 200	40	24
1·0% Chlorazol Drab RH 125 ...	42	19
1·5% Chlorazol Catechine B 125 ...	42	31
1·5% Chlorazol Green BN 125 ...	48	24
2·0% Chlorazol Black EN 2[illegible] ...	48	28
1·0% Chlorazol Black E 200 ...	48	[illegible]
1·5% Chlorazol Dark Green PL 125	49	30
1·0% Chlorazol Bordeaux BS ...	50	9
1·0% Chlorazol Black JH 200 ...	50	14
1·0% Chlorazol Orange Brown X 150	53	13
1·5% Chlorazol Brown LF 150 ...	58	26
0·5% Chlorazol Violet N 125 ...	59	34
0·5% Chlorazol Fast Orange R 150	59	13
0·5% Durazol Fast Yellow GR 200	60	15
1·5% Chlorazol Fast Orange D 125	66	33
0·5% Chlorazol Brown M 150 ...	74	12
0·5% Chlorazol Fast Scarlet 4B 150	75	21
2·0% Chlorazol Black GF 200 ...	77	29
2·5% Chlorazol Black LF 150 ...	77	24
0·5% Durazol Fast Yellow R 150	99	21
1·0% Chlorazol Steel Blue 6B 150 ...	130	18

It will be noted that there is a general tendency for the slower-migrating dyes to show a better exhaustion than the rapid-migrating dyes.

The Salt Controllability of Direct Dyes

The work already described enables dyes to be grouped according to their ease of migration. Those which migrate well should not give rise to much trouble in application, but it is desirable that their sensitivity to salt additions should be known so that some judgment can be made as to the quantity of salt to be added. In the case of those dyes which do not level well, information on the salt controllability is even more important, in order that the possibility of gradual exhaustion by successive additions of salt may be investigated. Accordingly, the salt controllability of all the dyes has

been determined. The rate-of-dyeing curves and equilibrium exhaustions given in an earlier section of this paper already provide some measure of salt controllability, and it is particularly interesting to note how the salt controllability varies with liquor length—a point that must be borne in mind in any practical consideration of the use of salt controllability data. It is for this reason also that it was decided to investigate salt controllability in a long liquor, since the range of exhaustion produced by differing quantities of salt will then be very much greater. Accordingly, experiments were carried out in which cotton yarn was placed in a dyebath containing a know amount of calcined Glauber's salt and allowed to stand for 24 hr. in a thermostat at 90° C., the liquor-goods ratio being 60 : 1. After dyeing, the liquor was poured off and the fiber rinsed in cold water, dried and allowed to condition for 24 hr. The dye was then stripped by means of 25 per cent pyridine and the resulting solution examined in a photo-electric absorptiometer. In order to allow for any possible decomposition of dye, blank dyebaths of the same dye and salt concentration were prepared at the same time, heated under exactly the same conditions and then used as standards in the estimation of the dye on the fiber. The results are given in Table XIX.

From Table XIX it is immediately possible to predict the effect of any salt addition. For convenience, it is desirable to group the dyes roughly in order of salt controllability, but this is difficult as it is practically impossible to ascribe any single figure to a dye which will describe its salt controllability under all conditions, since the controllability changes continuously as salt is added. The difficulties of expressing salt controllability may be shown by considering the behavior of different dyes.

Considering the variations of exhaustion of two standard dyes with varying salt concentration, as shown in Fig. 12, it is seen that dye A has a high exhaustion in the absence of calcined Glauber's salt and is considered to be uncontrollable by salt for practical purposes, since the exhaustion increases only by 10 per cent on the addition of 20 per cent of calcined Glauber's salt. Dye B, on the other hand is considered salt-controllable, since its exhaustion is increased by 40 per cent on the addition of the same quantity of calcined Glauber's salt. If, instead of considering the increased exhaustion, the dye remaining in the bath is considered, then dyes A and B are equally salt-controllable, since in both cases the quantity of dye left after dyeing is reduced by 50 per cent, i.e. the residue for dye A decreases from 20 per cent to 10 per cent and for dye B from 80 per cent to 40 per cent. If the concentrated brands of the same dyes are examined, it is quite possible that a different state of affairs may exist, with dye A more controllable than dye B.

If the curve shown in Fig. 13 is considered, at point I the dye A is seen to be highly salt-controllable and dye B fairly salt-controllable. At point II dyes A and B have equal controllability, whilst at point III dye B is more salt-controllable than dye A. Hence, one dye may be more salt-controllable than another at one salt concentration and less controllable at a second salt concentration. It is not easy to find a simple method of expressing this complex behavior, but it does appear that the practical dyer is most interested in the change of exhaustion or change in depth of shade on the fiber produced by the first addition of salt. Accordingly, the dyes have been graded according to this behavior, using as a criterion the difference in exhaustion produced by adding the first 10 per cent of calcined Glauber's salt. This may seem rather a large addition, but the long liquor-length must be borne in mind. Salt controllability in this way is the proportional increase in apparent depth of shade produced by an addition of 10 per cent salt, and mathematically is expressed by—

$$S = \frac{M - N}{N}$$

TABLE XIX

Cotton Yarn: Percentage Exhaustion and Salt Controllability using a 60 : 1 Liquor-Goods Ratio

Dye	Exhaustion (%) Calcined Glauber's Salt on Weight of Cotton (%)— 0	2	5	10	20	40	100	200	Salt Controllability
0·5% Durazol Fast Yellow GR 200 ...	34	45	57	70	80	89	92	95	1·1
0·5% Durazol Fast Yellow G 400 ...	34	45	57	71	83	90	94	95	1·1
1·0% Durazol Fast Yellow 6GS ...	39	49	58	68	76	81	87	89	0·7
1·0% Chlorazol Yellow 6GS ...	14	18	23	30	40	52	70	80	1·1
0·5% Chrysophenine G 200	9	16	25	32	41	50	63	74	2·6
1·0% Durazol Fast Orange 2G 125	6	15	24	37	52	66	80	86	5·2
1·5% Chlorazol Fast Orange D 125	5	8	16	25	42	62	81	88	4·0
0·5% Durazol Fast Orange 4R 150	13	22	37	52	65	74	79	83	3·0
0·5% Chlorazol Fast Orange R 150	53	65	75	82	87	89	91	91	0·8
0·5% Chlorazol Orange PQ 150 ...	30	41	49	61	72	80	88	89	1·0
1·5% Chlorazol Brown LF 150 ...	31	40	49	59	68	75	81	84	0·9
0·5% Chlorazol Brown M 150 ...	42	53	63	74	82	88	93	94	0·8
1·5% Chlorazol Catechine B 125 ...	12	16	21	26	35	41	54	60	1·2
1·5% Chlorazol Catechine GR 150	24	28	32	39	47	55	64	71	0·8
1·0% Chlorazol Drab BH 125 ...	37	45	56	65	75	82	87	90	0·8
0·75% Durazol Fast Brown BR 150	39	69	76	83	89	92	94	94	1·1
1·0% Durazol Fast Orange Brown 2RS ...	19	29	40	51	65	74	81	85	1·7
1·0% Chlorazol Orange Brown X 150 ...	41	63	77	85	90	94	95	96	1·1
1·0% Chlorazol Orange Brown 2R 150 ...	32	38	45	51	58	63	71	74	0·6
1·0% Chlorazol Bordeaux BS	38	49	61	75	88	94	96	97	1·0
0·5% Chlorazol Bordeaux 6B 150 ...	27	36	47	57	67	76	83	89	1·1
0·5% Chlorazol Fast Pink BK 200	1	5	11	19	33	48	69	82	—
1·0% Chlorazol Fast Red F 125 ...	26	32	39	49	64	78	90	93	0·9
1·0% Durazol Red 2B 150	9	14	20	27	39	50	68	79	2·0
1·0% Chlorazol Fast Scarlet 4BAS ...	23	29	38	50	66	79	89	93	1·3
0·5% Chlorazol Fast Scarlet 4B 150	65	73	83	89	93	95	96	96	0·4
1·0% Chlorazol Fast Scarlet 4B 125	28	37	46	58	74	84	90	92	1·1
1·0% Chlorazol Fast Scarlet 6S ...	30	37	46	56	68	77	85	88	0·9
0·75% Durazol Fast Scarlet 2G 150	19	28	42	58	75	87	93	95	2·1
1·0% Durazol Fast Rubine B 150 ...	12	16	23	32	49	69	82	87	1·7
1·0% Durazol Fast Red 6BS ...	8	16	26	39	58	72	84	88	3·0
0·5% Chlorazol Helio B 200 ...	16	26	36	46	55	63	74	83	1·9
0·5% Chlorazol Fast Helio 2RK 200	18	30	41	51	61	69	78	84	1·8
0·5% Chlorazol Violet N 125 ...	32	47	63	77	86	90	92	93	1·4
1·0% Durazol Fast Violet 2BS ...	6	8	11	15	20	28	42	59	1·5
1·0% Chlorazol Blue B 200	10	16	23	34	47	61	76	84	2·4
1·0% Chlorazol Blue G 150	7	12	18	26	38	52	70	77	2·7
1·0% Durazol Fast Blue 3R 200 ...	13	22	33	42	53	70	86	93	2·2
1·0% Durazol Fast Blue 2R 200 ...	14	20	28	40	54	71	84	92	1·9
1·0% Durazol Fast Blue G 200 ...	14	20	28	40	54	71	88	94	1·9
1·0% Durazol Blue 2GN 200	17	25	36	50	66	71	84	89	1·9
2·0% Durazol Fast Blue 4GS ...	4	12	21	30	43	59	77	93	6·5
0·5% Durazol Fast Blue 4R 200 ...	6	13	25	39	59	63	91	94	5·5
0·5% Chlorazol Sky Blue FF 200 ...	23	34	49	64	80	88	91	94	1·8
0·5% Chlorazol Sky Blue GW 400	4	20	38	54	69	83	92	95	12·5
1·0% Chlorazol Steel Blue 6B 150...	5	23	44	61	75	83	88	92	11·5
1·5% Chlorazol Dark Green PL 125	34	43	52	60	68	73	80	85	0·8
1·5% Chlorazol Green BN 125 ...	57	63	72	81	87	92	95	96	0·4
1·5% Chlorazol Green GS ...	14	21	28	40	57	76	88	92	1·9
1·0% Durazol Brilliant Red B 150	8	15	25	38	56	71	84	91	3·7
1·0% Chlorazol Black BH 200 ...	25	33	42	55	69	80	88	93	1·2
2·0% Chlorazol Black EN 200 ...	39	46	52	59	67	74	79	83	0·6
2·0% Chlorazol Black E 200 ...	32	39	47	56	65	73	79	83	0·8
2·0% Chlorazol Black FF 200 ...	26	31	36	43	53	59	71	77	0·7
2·0% Chlorazol Black GF 200 ...	19	29	39	53	65	70	78	83	1·8
1·0% Chlorazol Black JH 200 ...	24	30	40	54	69	81	88	92	1·3
2·5% Chlorazol Black LF 150 ...	35	42	49	57	65	74	82	86	0·6
2·5% Chlorazol Black PB 150 ...	22	31	40	50	62	75	85	88	1·3
0·5% Durazol Grey N 150 ...	45	55	62	68	74	78	82	84	0·5
1·0% Durazol Grey RG 125	15	21	27	35	48	60	73	82	1·3
1·0% Durazol Fast Grey B 125 ...	11	16	23	36	53	67	77	84	2·3
1·5% Durazol Fast Grey GS ...	9	15	27	37	52	68	84	90	2·1
1·0% Durazol Fast Grey VG 150 ...	30	37	45	59	75	84	91	93	1·5
2·5% Chlorazol Diazo Black 3B 150	21	27	32	40	51	65	80	87	0·9
2·5% Chlorazol Diazo Black DB 150	20	25	31	39	52	65	81	89	1·0

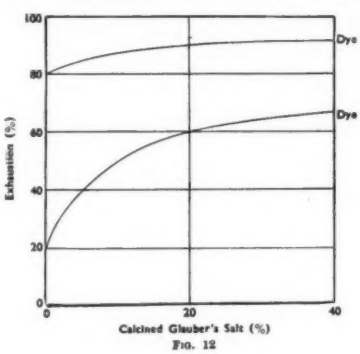

FIG. 12

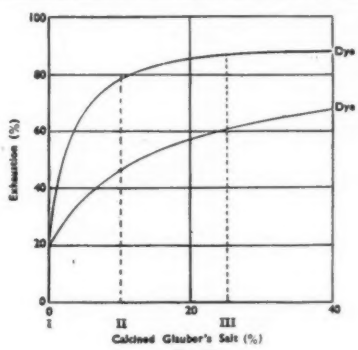

FIG. 13

(M = the exhaustion of the dyebath with 10% salt; N = the exhaustion with no salt; and S = the salt-controllability.)

Using this criterion, the dyes in Table XIX give controllability figures ranging from 0.4 to 12.5. The division of these figures into groups must be purely arbitrary, particularly as the figures show a tendency to cluster around the value of 1.0. Nevertheless, an attempt has been made to give some verbal description of the salt-controllability and the following groups are proposed—

Controllability by Salt	*Values*
Low	0.4-0.9
Medium	1.0-1.5
High	1.7-2.7
Very high	2.8 or higher

Effect of Temperature

Having selected from the direct dyes *(a)* those which migrate rapidly and *(b)* those which, although they migrate slowly, have a comparatively low exhaustion so that they can be applied in a controlled manner by gradual salt additions, there remains *(c)* a group of dyes which do not migrate easily and which have a comparatively high absorption in the absence of any added salt. With dyes in the third group the only way to retard initial absorption is to start dyeing at a low temperature and then gradually raise the temperature. The effect of temperature in dyeing with direct dyes is of considerable practical importance and has been made the subject of much investigation from both the theoretical and practical aspects. On the practical side, a number of tests have been devised, e.g. the temperature range test, in which dyeings are carried out at different temperatures for an arbitrary length of time, after which the depths of shade are examined and the dye is stated to have an optimum dyeing temperature corresponding to that temperature at which the heaviest dyeing is produced. This and similar empirical tests appear to have caused some confusion as to the precise effect of temperature, but, from the more fundamental work which has been carried out, the effect is perfectly clear. With all the dyes yet examined, an *increase* of temperature produces an increase of dyeing rate and a *decrease* in exhaustion, provided that the dyeing is allowed to reach equilibrium. This has been proved in the case of the dyes at present under examination by measuring the equilibrium exhaustion attained with all dyes, using a 60 : 1 liquor-goods ratio and adding 8 per cent calcined Glauber's salt at three different temperatures, viz. 90°, 60° and 40° C. In all cases it was found that the higher temperature produced lower exhaustion.

The observation that some direct dyes give heavier dyeing in practice at 90° C. than they do at 60° C. is due solely to the fact that, in the normal limited time of dyeing, the dyeing system has not reached equilibrium. This has been explained in detail in a previous publication[5]. The temperature range test is, in fact, an indirect method of measuring dyeing rate. If a dye attains equilibrium very quickly then it will give, in a normal dyeing time, the heaviest dyeing at the lowest temperature, whilst a slow dyeing dye, on the other hand, will show an increasing depth of shade with increasing temperature. The possibility of transferring a temperature range test carried out in the laboratory on a small scale to a full-scale dyeing machine requires further investigation, for the actual optimum temperature of dyeing will depend upon the arbitrary length of time selected for making the test and also upon the rate of circulation of dyeliquor. As already pointed out, if a very long time is allowed for the dyeing operation, then all direct dyes will have an optimum dyeing temperature of, possibly, 40° C. On the other hand, if the dyeing time is very much curtailed, it is probable that most direct dyes would show an optimum dyeing temperature of 90° C. Further, if the rate of circulation of liquor is increased, this will produce an increase in the overall dyeing rate, so that a dye which may show an optimum temperature of 80° C. with slow circulation might easily exhibit an optimum temperature of 40° C. with rapid circulation.

In view of these effects it is considered that the temperature range test is of doubtful value and, in any case, it cannot affect the treatment of dyes falling into the third class of the system now under consideration. The important effect of temperature is that with all dyes a reduction in temperature diminishes the dyeing rate. Consequently, it has not been thought necessary to study the effect of temperature in any further detail. If a direct dye falls into this third class, then temperature control is required, and no further instructions can be given as to the precise rate at which the temperature should or can be raised, as so much depends upon the design of the machine in use.

Classification of Direct Dyes

Using the information already given, direct dyes can be divided into the following three classes—

Class A: Dyes which Migrate Well—These dyes can be applied successfully under most conditions which are encountered in practice; in Table XX, which includes those dyes with times of half-migration < 20 min., they are arranged in the order of rate of migration. It will be obvious that under certain conditions those dyes near the end of the list may not be fully satisfactory as regards migration, and such dyes would then fall in Class B. The exhaustion of the dye without salt and the salt controllability are also given in Table XX, so that the necessity for adding salt in order to obtain good color value can be perceived, together with some indication of the care which is necessary in making the additions. It is noticeable that the majority of the dyes in this class show low exhaustion in the absence of added salt.

Class B: Dyes which do Not Migrate Well, but which have Low Exhaustion in Absence of Salt—With dyes of this class, the production of even dyeings is facilitated by the gradual addition of salt. The members of this class have been selected from those dyes not in Class A, the exhaustion of which in the absence of salt is < 30 per cent, using a 60 : 1 liquor-goods ratio. In Table XXI, these dyes are arranged in order of exhaustion without added salt, those of lowest exhaustion being placed first. Again, dyes near the end of Table XXI may under some conditions be better located in Class C. This is particularly the case when the liquor length is much reduced, and an indication of this is given by the exhaustion without added salt, using a 5 : 1 liquor-goods ratio, which is also given in Table XXI.

TABLE XX
Class A Direct Dyes on Cotton

Dye	Time of Half-migration (min.)	Exhaustion without added Salt in 60 Vol. (%)	Salt Controllability
Durazol Red 2B 150 ...	3	9	High
Durazol Fast Blue 4R 200 ...	4	6	Very high
Chrysophenine G 200 ...	5	9	High
Chlorazol Yellow 6GS ...	5	14	Medium
Chlorazol Fast Pink BK 200	6	1	Very high
Durazol Hello B 200 ...	8	16	High
Durazol Grey RG 125 ...	8	15	Medium
Chlorazol Blue B 200 ...	9	10	High
Durazol Fast Violet 2BS ...	9	6	Medium
Chlorazol Catechine GR 150	9	24	Low
Chlorazol Blue G 150 ...	10	7	High
Chlorazol Fast Hello 2RK 200	11	18	High
Durazol Fast Grey GS ...	13	9	Very high
Durazol Fast Rubine B 150	13	12	High
Chlorazol Orange PO 150 ...	14	13	Medium
Durazol Fast Blue 4GS ...	14	4	Very high
Durazol Fast Blue G 200 ...	16	14	High
Durazol Fast Blue 2R 200 ...	16	14	High
Durazol Fast Blue 3R 200 ...	16	13	High
Durazol Fast Yellow 6GS ...	16	39	Low
Chlorazol Sky Blue FF 200	17	23	High
Chlorazol Bordeaux 6B 150	17	27	Medium

TABLE XXI
Class B Direct Dyes on Cotton

Dye	Exhaustion without added Salt in 60 Vol. (%)	Salt Controllability	Exhaustion without added Salt in 5 Vol. (%)
Chlorazol Sky Blue GW 400	4	Very high	60
Chlorazol Steel Blue 6B 150	5	Very high	—
Chlorazol Fast Orange D 125	5	Very high	30
Durazol Fast Orange 2G 125	6	Very high	32
Durazol Fast Orange 4R 150	13	Very high	43
Durazol Fast Grey B 125 ...	11	High	—
Chlorazol Catechine B 125 ...	12	Medium	27
Chlorazol Green GS ...	14	High	75
Chlorazol Black GF 200 ...	19	High	45
Chlorazol Black PB 150 ...	22	Medium	—
Chlorazol Scarlet 4BAS ...	23	Medium	78
Chlorazol Black JH 200 ...	24	Medium	81
Chlorazol Black BH 200 ...	25	Medium	82
Chlorazol Fast Red F 125 ...	26	Low	74
Chlorazol Black FF 200 ...	26	Low	32
Chlorazol Fast Scarlet 6B 125	28	Medium	83

Class C: Dyes which do Not Migrate Well and have high Exhaustion in Absence of Salt—In order to obtain an even result with these dyes, it is desirable to raise the temperature very gradually in

the initial stages of dyeing. The members of this class are those which do not fall in Classes A and B, and in Table XXII the dyes are again arranged in order of exhaustion in absence of added salt. It should be noted, especially in this case, that the exhaustion figures are deceptively low owing to the long liquor in which the measurements were made. In shorter liquors the exhaustion figures are much higher, and for convenience the exhaustion using a 5 : 1 liquor-goods ratio without salt is also given.

TABLE XXII
Class C Direct Dyes on Cotton

Dye	Exhaustion without added Salt in 60 Vol. (%)	Salt Controllability	Exhaustion without added Salt in 5 Vol. (%)
Chlorazol Fast Scarlet G8 ...	30	Low	75
Chlorazol Brown LF 150 ...	31	Low	70
Chlorazol Violet N 125 ...	32	Medium	73
Chlorazol Black E 200 ...	32	Low	78
Durazol Fast Yellow G 400	34	Medium	87
Durazol Fast Yellow GR 200	34	Medium	65
Chlorazol Dark Green PL 125	34	Medium	81
Chlorazol Black LF 150 ...	35	Low	73
Chlorazol Drab RH 125 ...	37	Low	77
Chlorazol Bordeaux B8 ...	38	Medium	92
Chlorazol Black EN 200 ...	39	Low	74
Chlorazol Orange Brown X150	41	Medium	89
Chlorazol Brown M 150 ...	42	Low	89
Durazol Grey N 125 ...	45	Low	—
Chlorazol Fast Orange R 150	53	Low	90
Chlorazol Green BN 125 ...	57	Low	80
Chlorazol Fast Scarlet 4B 150	65	Low	95

Use of the Classification

The usefulness of this classification in the dyeing of shades of single dyes is self-evident. The class into which the chosen dye falls immediately indicates the general dyeing behavior and the practical method of application which is most suitable for obtaining level results. Dyes in Class A are easy to apply because of their good levelling power, and reference to the exhaustion with and without added salt gives an indication of the amount of salt needed to produce adequate exhaustion and whether or not any special care is needed during the addition, as shown by sudden increases in exhaustion with small additions of salt. It should perhaps be emphasized in this connexion (and the remark applies to all three classes), that the exhaustion figures given here have been determined in an extremely long liquor, so that in working with shorter liquors the exhaustion will be higher and the amount of salt required less in proportion to the liquor length. Thus, 10 per cent salt in a 30 : 1 liquor is equivalent to 20 per cent in the 60 : 1 liquor, and the exhaustion produced in the former case will actually be a little greater than that produced in the latter, because of the greater dye concentration in the dyebath and the shorter liquor. Dyes in Class B are rather more difficult to apply, but by gradual addition of salt may be applied evenly, whilst with dyes in Class C the dyeing must be started cool and the temperature raised slowly in the initial stages of dyeing.

Naturally, in any division into classes in this way, there will be anomalies and borderline cases which do not properly fall into any class, so that the data on any particular dye should be carefully examined and the grouping used with due regard to these special cases.

With regard to the selection of dyes for mixture shades, it is felt, in the light of the work on dyeing rate, that it is dangerous to suggest that compatible combinations can be selected on this classification basis. It is by no means certain that the migration of a dye is unaffected by the presence of a second dye on the same fiber, and certainly the salt controllability depends on the combination used. This latter effect will be particularly noticeable in short liquors, for if a dye containing little salt, and having low exhaustion and a correspondingly high salt controllability, is mixed with another dye which contains a high proportion of salt as diluent, the exhaustion of the first dye will be increased and it may become comparatively insensitive to further salt additions, thus moving from Class B to Class C. Further, the numerous other criteria of compatibility in combinations, which are of overriding importance, e.g. similar light- and washing-fastness and possibly dischargeability, render it very difficult to take into account the dyeing properties. It is suggested that, if possible, the dyes in a mixture should fall into the same class, but there is no real objection to mixing dyes of different classes, because in practice almost any two direct dyes can be used together if sufficient care is taken in application. In mixing dyes of different classes it is suggested that the choice of dyeing method should be governed by the dye which is most difficult to apply. Thus, in mixing dyes from classes A and B, the salt should be added very gradually, whilst with mixtures of dyes from Classes A and C or Classes B and C, the dyeing should be started cool, the temperature raised slowly, and then salt added gradually, if necessary.

In conclusion, it must be stated that this classification is not foolproof, and it is only by the intelligent use of all the data here provided that the full value of this information can be obtained. In particular, attention may be directed to the two tables of dip test results (Tables VI and VII), which are useful in indicating which dye in a binary mixture will dye the fiber first and the degree of dyeing compatibility.

The authors thank J. P. Gill and Dr. R. H. Peters, who determined some of the rate-of-dyeing curves, and particularly H. Aldred and G. K. O'Malley to whom, respectively, most of the data on rate of migration and salt controllability are due.

Imperial Chemical Industries Ltd.
Dyestuffs Division
Dyehouse Department
Blackley
Manchester 9.

References

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[2] Boulton and Morton, ibid., 1940, *56*, 145.
[3] Boulton, ibid., 1944, *60*, 5.
[4] Neale and Stringfellow, ibid., 1943, *59*, 241.
[5] Vickerstaff, ibid., 1943, *59*, 92.
[6] Hanson, Neale and Stringfellow, Trans. Faraday Soc., 1935 *31*, 1718.
[7] Davenport, J. Sci. Instruments, 1944, *21*, 84.
[8] Whittaker, J. Soc. Dyers & Col., 1942, *58*, 253.

• PATENT DIGEST •

FINISHING OF MIXED (WOOL/RAYON) KNITTED GOODS G. 1

U. S. Patent 2, 399,559 (Courtaulds Limited, McKeown, Penn., April 30, 1946)

The invention relates to a finishing treatment of mixed textiles and particularly of knitted goods consisting of equal parts of wool and viscose yarn. The products are intended for the use of garments for underwear. The goods are impregnated at the boil in a bath, consisting of Lissapol A (a fatty alcohol sulfate, manufactured by Imp. Chem. Ind.) and a small amount of an ammonium salt such as ammonium acetate (for instance 1.5 g. in one liter). After one hour treatment at or near the boiling point the ammonia has partly been volatilized and the pH value of the solution, being at the start 7.2, drops to 6.8. The fabric assumes a wool-like, warm handle, despite its high cellulose content.

Work done in this field: In recent times a resin finish for wool and mixed fabrics has been proposed in U. S. P. 2, 332,817 (du Pont). Brit. Pat. 551,511 (Creasa Ltd.) discloses that cellulose fibers can acquire a wool-like hand by impregnation with cellulose dispersions.

By Paul Wengraf

PRE-TREATMENT OF ACETATE CELLULOSE FABRICS C, 4, 03

U. S. Patent 2, 399,627 (Celanese Corp. of America, Croft-Hindle, May 7, 1946)

In dyeing acetate cellulose fabrics of the so-called "sharkskin" type, difficulties are encountered in jig dyeing: Shaded selvedges and endedness have often been observed here. Winch dyeing of sharkskin fabrics seems to be preferable as far as the uniformity of dyeings is concerned but in using this method creases are formed mostly due to the stiff character of the fabrics. The present invention suggests to apply as a preparatory step high concentrated Turkey Red Oil (at 50-80° C.) to the fabric. After drying the material becomes sticky and gummy but this unpleasant hand is removed by scouring it in a bath consisting of small quantities of Turkey Red Oil, xylene and water. A pliable soft fabric is obtained which can be dyed without risking the creases, mentioned above. Different scouring agents such as Gardinol WA, Igepon T, Parapon SA can be added to the scouring bath improving the effect of the Turkey Red Oil pretreatment.

Earlier work done in this field: U. S. P. 2, 347,001 (Schnegg, vested in the Alien Property Custodian) proposes to prepare acetate fibers by swelling them with high concentrations of acetic acid. Thereupon the material is treated with alkali acetate or the like and some wetting agents such as Peregal. U. S. P. 2, 376,890 (duPont): Cellulose esters are pre-treated with polyhydric alcohols such as glycerine to produce light and wash-fast dyeings.

TREATING STARCH FOR OBTAINING STABLE THICKENERS, SIZING PASTES, ETC. D, 1

U. S. Patent 2, 402,820 (Rohm & Haas Company, Glarum—Thomas, May 21, 1946)

The invention protected by this patent discloses quite generally a new method for treating starch in order to obtain a stabilized paste. It can therefore be useful for manufacturing thickeners in the printing industry, sizing, finishing or adhesive compositions. The process is a continuation in part of the Company's U. S. P. 2, 302,310 (corresponding also to B. P. 543, 432-33) which describes a method for stabilizing starch hydrolized in the wet way. The present patent relates to a treatment of pastes, *hydrolized in any possible way* (acid, heat or enzyme treatment). It is well known that quite generally starch pastes gel or that a supernatant layer separates out on standing. The new process consists of warming an aqueous slurry of hydrolized starch with relatively *small amounts* of urea-formaldehyde (preferably plus melamine) condensate. It is stated that the condensate combines upon warming with the hydrolized starch, converting it into clear, viscous stable pastes. Ordinary starch pastes, boiled with borax are known to be too stringy and too "long" for use but a paste, treated with 1-10 per cent urea-formaldehyde condensate *and* borax proved to be an excellent adhesive.

Work done in this field: Starch-aldehyde-urea compounds have been proposed for pressure molding purposes (for instance described in Ger. P. 712,122, van Linge). Rohm & Haas give in another patent (U. S. P. 2, 342,785) a formula for preparing water-resistant coatings by curing starch-mixed aldehyde-urea resins upon the fiber. Hjelmstad discusses in Paper Trade Journal 1945, No. 16, p. 56-58, the new reaction products between starch and urea-formaldehyde resins, describing the modification of starch obtained by this reaction.

NON GELLING STARCH COMPOSITIONS G, 1

U. S. Patent 2, 400,402 (General Mills, Inc.—Evans—May 14, 1946)

(Compare abstract to U. S. P. 2, 402,820 above).

A starch possessing non-congealing properties is prepared by mixing an insoluble starch preparation (for instance an acid modified wheat starch) with an alkylolamine soap. The formula given in one of the examples reads: 99 parts starch to one part triethanolamine. Other alkylolamine soaps can be used (proportion 0.5-2.2 per cent calculated on the amount of the starch product). The finished product was found to be non-congealing according to the Federal Standard Test.

MILDEWPROOFING TEXTILES G, 1

U. S. Patent 2, 401,028 (U. S. Rubber Company, terHorst, May 28, 1946)

Textile and leather materials are proofed against mildew by using a solution of phenanthrene quinone, a compound described first by Graebe (1873) and intended for use in dyestuff manufacture. The substance is not water soluble but soluble in acetone and it is deposited from a solution having a concentration of 0.25 per cent. The air dried fabric was very resistant to mildew when buried for some weeks in the soil and the tensile strength of the yarns remained almost unchanged, while untreated material was heavily overgrown with mildew under the same conditions and had lost about 90 per cent of the original strength.

Earlier work: Literature of mildew proofing products has become very abundant in the last years, certainly due to military requirements. Various organic compounds, particularly such which contain chlorine, substituting aromatic rings, are described. For instance, chlorinated phenols are the products recommended in U. S. P. 2,292,423 (Goodrich); chlorobenzylphenylethers (U. S. P. 2,392,733, du Pont); tetrachlorotetrahydronaphtalene (U. S. P. 2,368,667, U. S. Rubber); hexachlorodioxydiphenylmethane (U. S. P. 2,353,725, Bush & Gump) etc., etc.

CELLULOSE-PHOSPHONAMIDE AS A FLAMEPROOF MATERIAL G, 2, 03

U. S. Patent 2, 401,440 Monsanto Chem. Co., Thomas-Kosolapoff, Inc., 4, 1946)

A new cellulose derivative is described in the present patent. It is obtained by first treating cellulose with phosphorus oxychloride and thereupon with ammonia. This compound is a *phosphonamide* of cellulose and the reaction is characterized by the following equation (Cell OH being the schematic formula for celluuose):

$$\text{Cell OH} \xrightarrow[\text{treatment}]{POCl_3} \text{Cell-O-POCl}_2$$

$$\xrightarrow[\text{treatment}]{NH_3} \text{Cell-O-P(=O)(NH}_2\text{)-NH}_2$$

or in the presence of moisture

$$\text{Cell-O-P(=O)(OH)-NH}_2$$

Probably however not simple compounds but polymers are formed in this reaction. In an example cotton cloth is placed in a vessel, filled with pyridine, and Phosphorusoxychloride is added while cooling. The vessel is maintained in a bath at about 60°C over night and aminated. The fabric becomes incombustible and keeps this property even after repeated washing operations. Other examples relate to loose cotton material.

Former work done in this field: Cellulose *amines* are described by Scherer and Field in Rayon Text. Monthly 1941, p. 607: real amines are formed which combine even by diazotation to dyestuffs. Amino-products as well as phosphoric acid derivatives themselves are to a certain extent fireproofing agents; ammoniumphosphate, described in Swiss Patent 213,231 for flameproofing purposes. Polyethylene imines, combined with phosphoric acid, mentioned in U. S. P. 2,286,726 (du Pont); amidomethylphosphonic acid in U. S. P. 2,304,156 (du Pont) and so on.

Proceedings of the
American Association of Textile Chemists and Colorists

SEPTEMBER 9, 1946

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STUDENT CHAPTERS

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North Carolina State College
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Members should notify the Secretary immediately of all address changes

Plan now to attend the

Silver Jubilee Convention A. A. T. C. C. 1921-1946

Under the Auspices of the

Northern New England Section

December 12, 13, 14

Hotel Statler
Boston, Massachusetts

Watch for further announcements by mail and in the pages of the Reporter

Executive Committee

BACK ROW:—left to right—Azel W. Mack, Printing, Registration and Personnel; Joseph A. Bryant, Jr., Dining; Hyman P. Selya, Publicity; Philip S. Durfee, Finance; Harry M. Hartnett, Hotel.

FRONT ROW:—left to right—Delbert E. Ray, Exhibits; Edward S. Chapin, Reception; George O. Linberg, General Chairman; Walter J. Hamburger, Technical Program.

Representing the

Northern New England Section

ALUMNI GROUP LUNCHEON PLANNED FOR SILVER JUBILEE CONVENTION

ONE of the features of the Annual Meeting to which many will look forward is the Alumni Group Luncheon planned for Saturday noon, December 14, 1946. This informal meeting will be held at the Statler Hotel, the headquarters for theh Silver Jubilee Convention. Reservation cards will be sent with the notice of the Convention. It is planned to have leaders from the various textile schools in attendance.

Ralph E. Hale, an alumnus of the Lowell Textile Institute, is Chairman of the Committee and is being assisted by the following alumni:

Ernest R. Kaswell, Massachusetts Institute of Technology; Harold C. Wood, Philadelphia Textile Institute; Richard O. Barry, New Bedford Textile School; William M. Thornton, Rhode Island School of Design; T. Arthur McCann, Bradford Durfee Textile School; and Fred R. Tripp, North Carolina State College.

Any other groups or those seeking further details should contact Ralph E. Hale, The Bell Company, Worcester 5, Massachusetts.

EMPLOYMENT REGISTER

This column is open for four insertions per year, per member, without charge. Blanks can be obtained from, and filed with, the Secretary of the Association, Lowell Textile Institute, Lowell, Mass. It is understood that these will be open to inspection by prospective employers, who can obtain further information thro.:gh the code numbers from the Secretary.

46-5

Education: Lowell Textile School, Night. Chemistry, 1942.
Experience: Hosiery dyeing and finishing.
Age 29; married; references.

46-7

Education: Graduate, Bradford Durfee Textile School, 1933.
Experience: Five years as Textile Engineer, developing Non-woven fabrics.
Age 31; married; 3 dependents; references.

46-9

Education: Graduate, Philadelphia Textile Inst., Chem. & Dye.
Experience: Inspector, Quartermaster Corps. Staff Sgt., U.S.A.A.F., Sta. Chief, Meteorology.
Age 24; married; references.

46-10

Education: B. S., Pratt Inst.
Experience: Leather finishing. U. S. Army Medical Corps, Pharmacist, C. W. S. Instructor. Lab. application work on textile chemical specialties. Development of colors in laboratory and pilot plant. Interested in tech. sales service.
Age 31; single.

46-11

Education: PhD. Chem. Engg., Geneva, Switzerland.
Experience: Chief Chemist of Textile Mills, silk and cotton.
Age 57; single; references.

46-12

Education: Graduate New Bedford Textile School, 1945.
Experience: Laboratory technician, chemical, and physical testing.
Woman, age 20, single: references. Employment near Atlanta, Ga., preferred.

46-14

Education: B.S., Brooklyn College, 1934. courses in New York Textile High School, Brooklyn Polytechnic Inst., Columbia University.
Experience: Textile Technologist and Chief Chemist, analytical and testing.
Age 34; married; references.

46-15

Education: High school.
Experience: Leather and fur dyeing, 28 years.
Age 52; married.

46-16

Education: High school; Lowell Textile Evening School; N. H. State Univ., extension course.
Experience: 21 years dyeing cotton and mixtures, and hosiery.
Age 46; married; references. North preferred.

46-17

Education: Temple University.
Experience: Dyer, considerable variety of fibers and materials, 18 years.
Age 39; married; references. Will work anywhere in U. S.

46-18

Education: graduate Lowell Textile Institute, high standing, 1946.
Experience: two summers in textile plant laboratories.
Age 25: veteran; unmarried.

CALENDAR OF COMING EVENTS

SOUTH CENTRAL SECTION:
Meeting: September 21
(Patten Hotel, Chattanooga, Tenn.)

SUB-COMMITTEES
Meetings: September 26
(Hotel Commodore, New York)

COUNCIL:
Meeting: September 27
(Hotel Commodore, New York)

RESEARCH COMMITTEE:
Meeting: September 27
(Hotel Commodore, New York)

PHILADELPHIA SECTION:
Meetings: September 27, November 15, January 17, February 28, April 11, May 23.

NEW YORK SECTION:
Meeting: October 18
(Swiss Chalet, Rochelle Park, N. J.)
Meetings: November 22, January 31, March 7, May 2

MID-WEST SECTION:
Meeting: October 19
(Bismarck Hotel, Chicago)

PIEDMONT SECTION:
Meeting: October 26
(Charlotte, N. C.)

SOUTHEASTERN SECTION:
Meeting: October 26
(Ansley Hotel, Atlanta)

NATIONAL CONVENTION:
Silver Jubilee Convention: December 12, 13, and 14.
(Hotel Statler, Boston)

HOTEL RESERVATIONS

PLANS for the Silver Jubilee Convention in Boston are progressing under the leadership of George O. Linberg, General Chairman. Each member has, or will, receive a card on which he can specify the type of hotel accommodation desired. All requests for hotel reservations are to be handled by the Housing Bureau, 80 Federal Street, Boston, Mass. Reservations will be acknowledged from this office and assigned to various hotels which will, in turn, give a direct confirmation on each reservation. We would suggest that members do not contact the hotels directly on room reservations. The Committee feels that ample hotel space will be available.

NEW PRODUCTS • TRADE NOTES

• REINFORCEMENTS OF SCIENCE

According to a Government review, the expenditures of manufacturing corporations on research increased from $116,000,000 in 1930 to $240,000,000 in 1940 while government research was rising from $24,000,000 to $69,000,000 and endowed researches of colleges and institutes from $25,200,000 to $35,500,000. There were 265 industrial research laboratories staffed by 7400 technically trained men in 1920 versus 2350 laboratories and 70,000 scientists and technicians in 1940. Procedures based on trade traditions alone are almost surely obsolescent and progressive manufacturers equip to challenge and improve everything their plants are doing. Many manufacturers develop their own staffs, pharmaceutical manufacturers support and depend extensively on clinical studies in medical schools and hospitals, and small as well as large manufacturers tap the resources of capable institutes, university departments and commercial research service agencies. Modern business has learned how well it pays to "know its onions" within its logical field.

The findings of the thousands of researchers who have thus been added to the armies of science do not remain secret. In chemistry, reliance upon secret processes without exhibition in patents is becoming very rare; modern analytical methods penetrate too easily the "chemical blankets" of a generation ago! To protect new inventions, patents are commonly applied for but they must be applied for promptly and are usually pressed to early issue, whereby the knowledge, if not the rights, becomes public property and a stimulus to rival workers.

In chemistry, including medicinals, the art moves so fast that licenses of patented invention to logical licensees are often the surest route to obtaining the fullest rewards from an invention since otherwise competitors, denied a license, will swiftly turn up with parallel products. Few inventions remain a real patent monopoly for the 17 years that patents run; similar or better ones come in and enjoy their own few years of preeminence so that the expiration of a patent nowadays only occasionally finds other manufacturers waiting to rush into the field with identical products.

The promptness and swiftness of the utilization of inventions developed by corporation research constitute another important credit to the public benefit. The new invention is commonly related to the sponsor's older products already in competitive manufacture, and the sponsor has not only the incentive but the equipment and skilled workers for a fast get-away.

In the area of investigational methods, industrial technicians exchange their new ingenuities with about as easy a freedom as do workers in college laboratories. An improvement in a laboratory instrument, a short-cut in analysis, the establishment of a new basing point for comparative evaluations are published speedily and unreservedly in technical publications and convention papers so that all may employ the new techniques.

On every point, the public is the gainer by the coming of the great industrial reinforcements of scientific inquiry.—*"For Instance," Publication of American Cyanamid Company.*

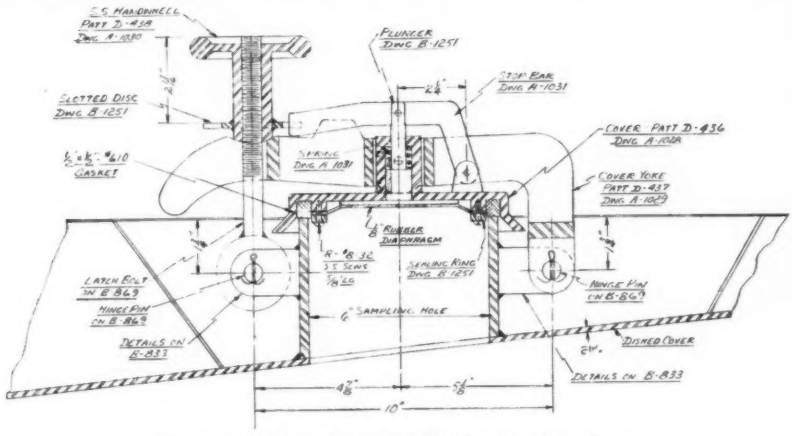


Diagram of Riggs & Lombard Safety Sampling Cover

• SAFETY SAMPLING COVER

Riggs & Lombard, Inc., Lowell, Mass., have anounced a safety sampling cover (patent applied for) which, it is claimed, will avoid accidents to personnel who open the sampling cover while a stock dyeing machine is in operation.

Just under the cover a rubber diaphragm has been inserted, which is expanded upward by the pressure in the machine when operating, and which resumes its normal position when the machine stops. When the diaphragm is in the upward position it pushes up a plunger attached to it, which in turn raises a stop bar to engage a slotted disc on the handwheel shaft. This makes it impossible to turn the wheel which opens the cover while the machine is in operation. (See drawing.)

This safety device is a standard feature of all new Fleet Line Stock Dye Kettles being shipped. It may also be added to machines now in place.

• CEGLIN FOR PILE FABRICS

Using a compound of "Ceglin" cellulose ethers and rubber latex as a backing composition for pile fabrics, Sylvania Industrial Corporation has developed a new method of finishing such materials so that they are said to be rendered more resistant to ageing and laundering. The process is covered by U. S. Patent 2,391,867, issued to James Andrew Clark and assigned to the company.

According to the terms of the patent, the new method also decreases the quantity of rubber latex used in the treatment of pile fabrics and produces a fabric in which the piles are permanently bound to the ground material in a manner that secures the pile yarns against withdrawal.

The patent states that, a pile fabric of any type may be treated, preferably by back filling, with a composition of "Ceglin" and rubber latex, which is conjointly coagulated upon the fabric, forming a continuous permanent coating which binds the pile tufts and individual fibers to the ground threads of the fabric. Various pigments, fillers and the like may be added to the mixture before or during application of this composition to the fabric.

• CALCO ORGANIZATIONAL CHANGES

The Calco Chemical Division, American Cyanamid Company, Bound Brook, New Jersey, announces the following organizational changes in its Control and Development Department:—

Dr. W. A. Raimond and Dr. T. H. Thelin have been appointed chief chemists of the Vat Dyes and Intermediates Division, respectively.

Dr. G. S. Herrick, Dr. C. E. Lewis and Dr. R. H. Ebel have been appointed assistant chief chemists of the Basic Dyes, Organic Pigments and Rubber Chemicals Divisions, respectively.

• VACUUM PICKUP UNIT

Increasing wear-testing efficiency and promoting greater accuracy of results, a new Abraser accessory for use in abrasion-resistance testing of textiles has been developed by Taber Instrument Corporation, 111 ADR Goundry Street, No. Tonawanda, N. Y.

Known as the Vacuum Pickup Unit, Model 100-108, this latest Taber development in precision abrasion measurement is reported to accomplish this dual objective by rapidly and thoroughly removing lint and abradings from textiles, including open-weave fabrics.

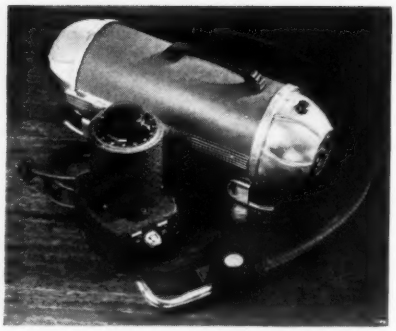
The device, the manufacturer asserts, thus assures continuous maintenance of uniformly effective contact of the abrading instrument's calibrase wheels against the specimen, making it possible to obtain more accurate results in abrasion-testing than generally possible heretofore.

In wear-testing textiles, Taber engineers point out, complete removal of abraded particles is a vital requirement; otherwise, test is usually prolonged and result impaired by unremoved abradings filling up the weave. The Vacuum Pickup Unit eliminates this frequent deterrent to quality testing, the manufacturer says.

A powerful two-stage turbine vacuum unit, the device provides three principal operating features: an adjustable suction control, variable voltage transformer, and an adjustable swivel nozzle that is easily, quickly rotated to proper position required for removing abradings from wear-path of wheels.

Standing on the floor completely out of the operator's way, the horizontal tank of unit is connected to the Abraser by a rubber-covered flexible tube. Nozzle assembly is mounted on right-hand arm support of Abraser and adjusted to proper height for thickness of specimen undergoing test. It is also said this equipment requires no special maintenance.

A cylindrical-shaped variable voltage transformer is available in two different voltage capacities to meet individual circuit requirements. The first, designed for 115v-50/60-cycle operation and having 7.5 amp capacity, is equipped with 0-120v variable voltage plug receptacle for suction motor, and two 115v, 5 amp capacity plug receptacles for Abraser and an illuminated magnifying glass.



Vacuum Pickup Unit for Taber Abraser.

The other model, for 230v-50/60 cycle operation, has 0-120v variable voltage plug inlet of 3 amp capacity at 115v for vacuum unit cord, plus dual 115v-1.0 amp outlets for Abraser and magnifier. Both models, equipped with Powerstat Dial Suction Control, have on the front panel of the base an off-on line switch for governing operation of all apparatus connected to unit, indicator light to show when transformer is connected to or disconnected from current supply line, and an off-on switch for operational control of transformer.

Complete data is available on request.

• MOVE NEW YORK OFFICE

Welch, Holme & Clark Co., Inc., are moving from 563 Greenwich St., New York, to 439 West Street, New York, about September 15th. The new 'phone numbers will be CHelsea 3-6048, 6049, 6050 and 6051.

• PHILADELPHIA OFFICE, HEYDEN

The Heyden Chemical Corporation announces the opening on September 1st of a sales and business office at 1700 Walnut Street, Philadelphia, Pennsylvania.

• TO RECEIVE I. R. I. MEDAL

Willis Rodney Whitney will receive the first Industrial Research Institute Medal at a dinner on October 17 during the fall meeting of the Institute at the Westchester Country Club, Rye, N. Y., Dr. Chas. S. Venable, President of the Institute, has announced.

Dr. Whitney is being honored for his outstanding contributions to the field of industrial research as a distinguished scientist, a pioneer of industrial research, and a leader and molder of men.

Organizer in 1900 of the General Electric Research Laboratory, he was its presiding genius and inspiring leader until his formal retirement in 1932. Since then his influence has continued through his almost daily presence at the Laboratory. Dr. Whitney pioneered the application of pure science to industrial technology with signal success and has largely set the pattern and philosophy of the modern industrial research laboratories.

This will be the initial presentation of the Industrial Research Institute Medal and it is appropriate, said Dr. Venable, that the "dean of industrial research directors" should be the first to receive it. The rules governing the award state that it shall be presented by the Institute as a high honor and shall be given for an outstanding contribution to the field of industrial research. This is to be interpreted in a broad sense as including publications, papers presented, discussions, educational work, technical achievement if it contributes broadly to industrial research, methods of operating industrial research laboratories, matters dealing with personnel, group leadership in industrial research, management leadership in industrial research, or other accomplishment which promotes the interest of industrial research.

• JOIN EMERY INDUSTRIES

Three veterans of World War II have joined the Emery Industries, Inc., organization, A. W. Schubert, vice president of the Cincinnati firm announced recently.

New director for Emery's research on plasticizers, resins and surface coatings is Maj. Robert Van Tuyle, for four years in charge of research on fabric coatings for the Chemical Warfare Service at Massachusetts Institute of Technology.

Col. E. R. Baker, formerly assistant chief of the Technical Division for Research and Development of the Chemical Warfare Service, has joined Emery's staff to head the newly created Development Department which was established to improve and extend the use of all its products, including several as yet in the pilot-plant stage.

Don Smith, who comes to Emery from the Chemical Warfare Service at M.I.T., will direct product research for the Candle Division which has just been moved into a large new plant in Mariemont, Cincinnati suburb.

• NEW PIGMENT

Brighter, cleaner, and more durable shades of brown colors for industrial enamels, trim paints, wallpaper and other coated papers, textiles, and possibly plastics are forecast in an announcement by the Du Pont Company of a new pigment color under the name "Auric Brown."

The new pigment, which is chemically

P. M. Dinkins, who has been made president and a director of Jefferson Chemical Company, Inc. Jefferson Chemical was organized in November, 1944, by American Cyanamid Company and the Texas Company to produce chemicals from petroleum, and petroleum gases. Its first plant, now under construction at Port Neches, Texas, will produce intermediate chemicals used in the synthetic rubber, plastics, textile and other industries. Mr. Dinkins has been associated with the American Cyanamid Company since 1923. He received his B.S. in chemical engineering from M.I.T. in 1918.

hydrated ferric oxide and is characterized by an extremely small particle size, promises outstanding resistance to light for a wide range of products, the company said.

All the possible uses of the new pigments have not been explored, the announcement said. It has shown to give very fast-to-light shades on coated and other papers such as those used for wallpaper. The fastness to light and resistance to alkali of this pigment recommend it as a background color in wallpaper and other coated coloring applications, as well as in the field of beater coloring of paper and textile printing.

The new pigment is now available to the manufacturing industries.

• TESTING PRICE LIST

The United States Testing Company, Inc., has published, and is now distributing to its clients, a booklet entitled, "Testing Price List." The booklet features specific test charges for textiles, chemicals, plastics, metals and many other materials.

Copies of the booklet may be obtained by making request at Company's main laboratories in Hoboken, New Jersey.

• CELANESE APPOINTMENTS

Executive appointments in the Chemical Division have been announced by Celanese Corporation of America. J. D. Fennebresque was appointed General Manager of the Chemical Division and W. Ward Jackson was named Sales Manager.

Prior to joining the Celanese organization in October, 1944, Mr. Fennebresque was variously assistant to the Chief of the Development Branch of the Office of Rubber Director, the Monsanto Chemical Company, the War Production Board, and, during the war, a member of the Joint Technical Industrial Intelligence Committee.

Mr. Jackson has been with the Celanese Plastics Division since 1931 and recently has been in charge of the Product Application Division in the plastics field.

• DETROIT MANAGER, WESTVACO

Donald C. Oskin, who joined Westvaco Chlorine Products Corporation, New York, late last year after serving for four years as a Major on the staff of General Doolittle, has been made Resident Manager of the recently opened Westvaco office at 1900 East Jefferson Street, Detroit 7, Michigan.

Mr. Oskin is a graduate of Lehigh University and was associated with the Bethlehem Steel Company in Technical Sales capacities before entering the Army.

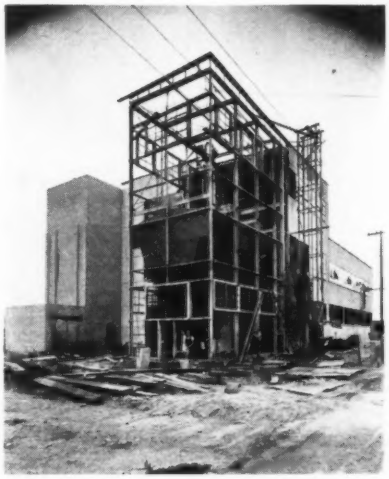
• L & N EXHIBIT

Everyone concerned with the operation of a chemical process will find the answers to many measurement and control problems at Leeds & Northrup's exhibit at the National Chemical Exposition, where a comprehensive line of instruments and accessory equipment will be demonstrated. L & N will have on hand, besides their time-proved standard equipments, some of the latest developments in instruments for the chemical field.

For industrial applications involving measurement and control of temperature, pH and electrolytic conductivity, the well-known Micromax recorders will be shown —round and strip-chart models, single and multiple-point, with either electric or penumatic control systems. And for those applications which demand extra speed and sensitivity, there will be L & N's Speedomax high-speed recorders, particularly useful in measuring and controlling fast-changing quantities and in extra-rapid multiple-point recording — also well adapted for laboratory use in microphotometry, X-ray, infra-red and mass spectrometry. A new type of Speedomax will be displayed—a high-speed fifty-point temperature indicator that gives centralized, exceptionally fast readings of temperatures at widely scattered points.

Where neither indicating nor recording is required, a brand-new type of instrument will be demonstrated—the Electromax signalling controller, useful in a number of temperature or conductivity applications. Simple and compact, it operates with full Micromax dependability.

L & N's field engineers will be on hand to demonstrate how these instruments can solve today's measurement and control problems.



Protein from soybeans, which will subsequently be made into soybean fiber and will be used also in the manufacture of many other products, will be the main activity in this new protein extraction plant of the Drackett Company, at its soybean processing center at Sharonville, near Cincinnati, Ohio. The finishing touches are now being put on this new plant, which will provide sufficient soybean protein to permit the company to step up sharply its output of soybean fiber. Concurrently the company is completing at this same center a new plant for the manufacture of this fiber.

Ambrose R. Chantler, who, as noted in our August 12th issue, has assumed the new position of general director of sales of the dyestuff division of E. I. du Pont de Nemours & Co., Inc.

• GERMAN SCREEN PRINTING

Fine detail in reproductions of photographs and drawings has been achieved by the Germans with a screen printing process which uses a newly developed pho-

Clark B. Shepherd, formerly manager of solvents development in the DuPont Company's Electrochemicals Department, who has been named manager of the Solvents Division. He succeeds E. W. McGovern, who has been assigned other executive duties in the Electrochemicals Department. J. W. Faassen succeeds Mr. Shepherd as manager of solvents development. Mr. Shepherd received his B.S. from Drexel Institute and joined DuPont as a chemist in the Experimental Station the same year.

George W. Gregg, who has been appointed sales manager of the newly formed Southern Region of Nuodex Products Co., Inc., with offices at 411 Bienville Street, New Orleans, La. Thompson Hayward Chemical Co. will continue as Nuodex agents in New Orleans and Mr. Gregg will be responsible for Nuodex activities among all agents in the new territory which includes North and South Carolina, Georgia, Florida, Alabama, Mississippi, Louisiana, Arkansas, Texas, Oklahoma and Tennessee. The Nuodex agents and their offices in the new Southern Region are: Thompson Hayward Chemical Co., Dallas, Houston and San Antonio, Texas; Memphis, Tennessee; New Orleans, La.; Oklahoma City and Tulsa, Oklahoma; R. T. Hopkins, Atlanta, Ga.; Post Brokerage Co., Nashville, Tennessee; and C. H. Patrick, Salisbury, N. C.

Dr. Bernard H. Gilmore, who has joined the research and product development staff of Calgon, Inc. Dr. Gilmore participated in the initial research on applications for Calgon in the textile industries when he was on the staff of Hall Laboratories, prior to the establishment of Calgon, Inc., as an associated concern. From 1933 to 1939, he conducted investigations under the Calgonizing Fellowship at Mellon Institute on the improvement and standardization of methods and processes of textile and laundry practice. His principal responsibility in his new position will be the development of new applications in the food industries.

to-sensitive polyvinyl acetate lacquer, according to a 17-page report now on sale by the Office of Technical Services, Department of Commerce.

The process is described by Francis L. Richardson, U. S. Army Quartermaster Corps consultant, who states that screens produced by this process are highly durable and resistant to chemical action. The method was developed at the Hoechst plant of I. G. Farbenindustrie.

A freshly mixed solution of saponified polyvinyl acetate and ammonium bichromate is painted over a bronze or silk gauze screen. A positive print of the design is placed over this photosensitive surface, which is then exposed to direct light for several minutes. The light causes the bichromate to oxidize the exposed plastic coating into an insoluble film.

The screen is rinsed in cold water in a darkened room, and then washed in hot water to remove the unexposed portions of the lacquer. Before printing, the lacquer is further hardened by dipping the screen into a formaldehyde solution.

The unique feature of this process is the toughness of the photosensitive lacquer. The finished screen requires no hand-applied reinforcement coat of lacquer, which would cut down on the fineness of detail and accuracy of reproduction.

A similar German process, developed by Klimsch and Co., Frankfurt/Main, is described in the same report by Dr. M. L. Crossley, also consultant with the U. S. Army Quartermaster Corps. In this method, a copper cloth, similar to that used to filter gasoline, is coated with a solution of polyvinylchloride and ammonium bichromate. Exposure and washing processes are the same as for the I. G. Farben method. The lacquer does not require any further hardening before printing.

In this method, designs may also be drawn directly on the screen. Screens prepared in this manner were said to be used for printing on both textiles and paper.

Printing processes for both methods are similar to those used in regular screen printing.

Orders for the report (PB-23638; photostat, $2; microfilm, 50 cents), should be addressed to the Office of Technical Services, Department of Commerce, Washington 25, D. C., and should be accompanied by check or money order, payable to the Treasurer of the United States.

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● JOINS I.T.T.

Lt. Cdr. Peter M. Strang, USNR, has joined the staff of the Institute of Textile Technology to work on textile machinery development. He comes to the Institute after 3½ years' service in the Navy as Resident Naval Inspector of Ordnance at Danbury, Connecticut, where precision bearings for the Norden bomb sight were made.

Mr. Strang is a graduate of Massachusetts Institute of Technology and has had advanced study at MIT and other schools. He has been interested in various aspects of textile research, particularly mill development and new equipment, all his life. His first association was with the engineering firm of Lockwood-Green, followed by work with a mill supply firm in Spartanburg, S. C. For six years he was senior cotton technologist with the U. S. Department of Agriculture.

Mr. Strang is a frequent contributor to various technical journals, his publications including such articles as "Mill Consumption of American Cotton by Grade and Staple," "Sun Spots, Ionization of Air and Textiles," "Some Phases of Cotton Character," and numerous others.

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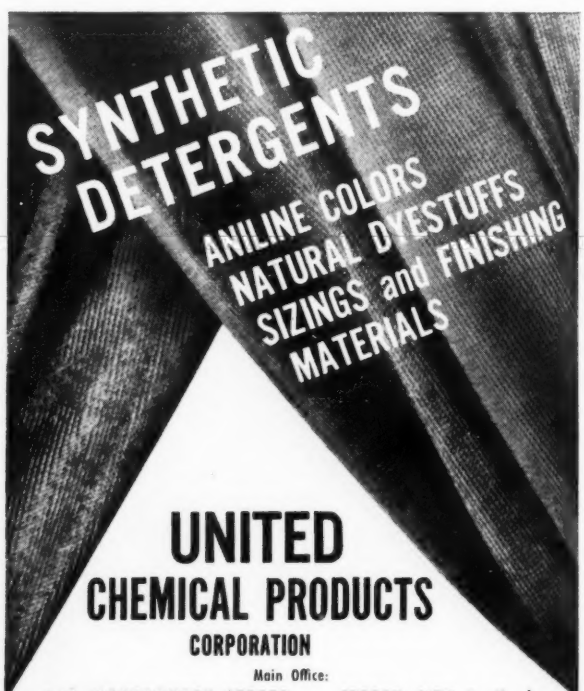

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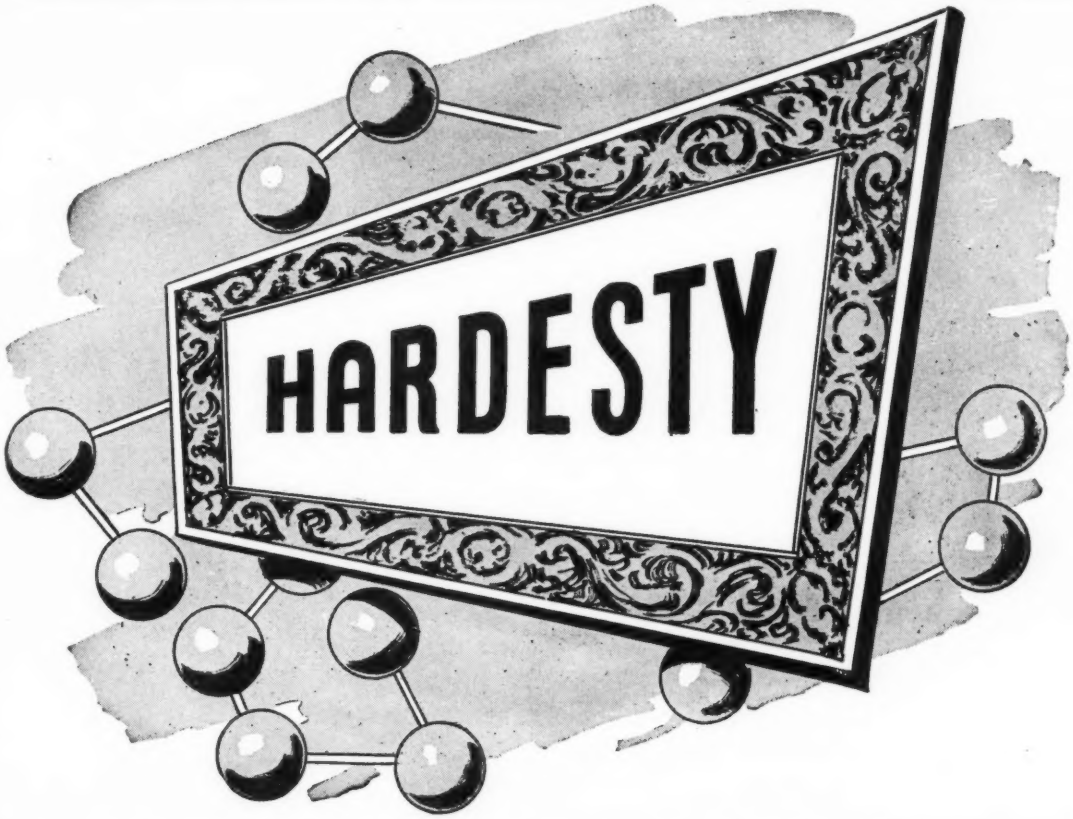

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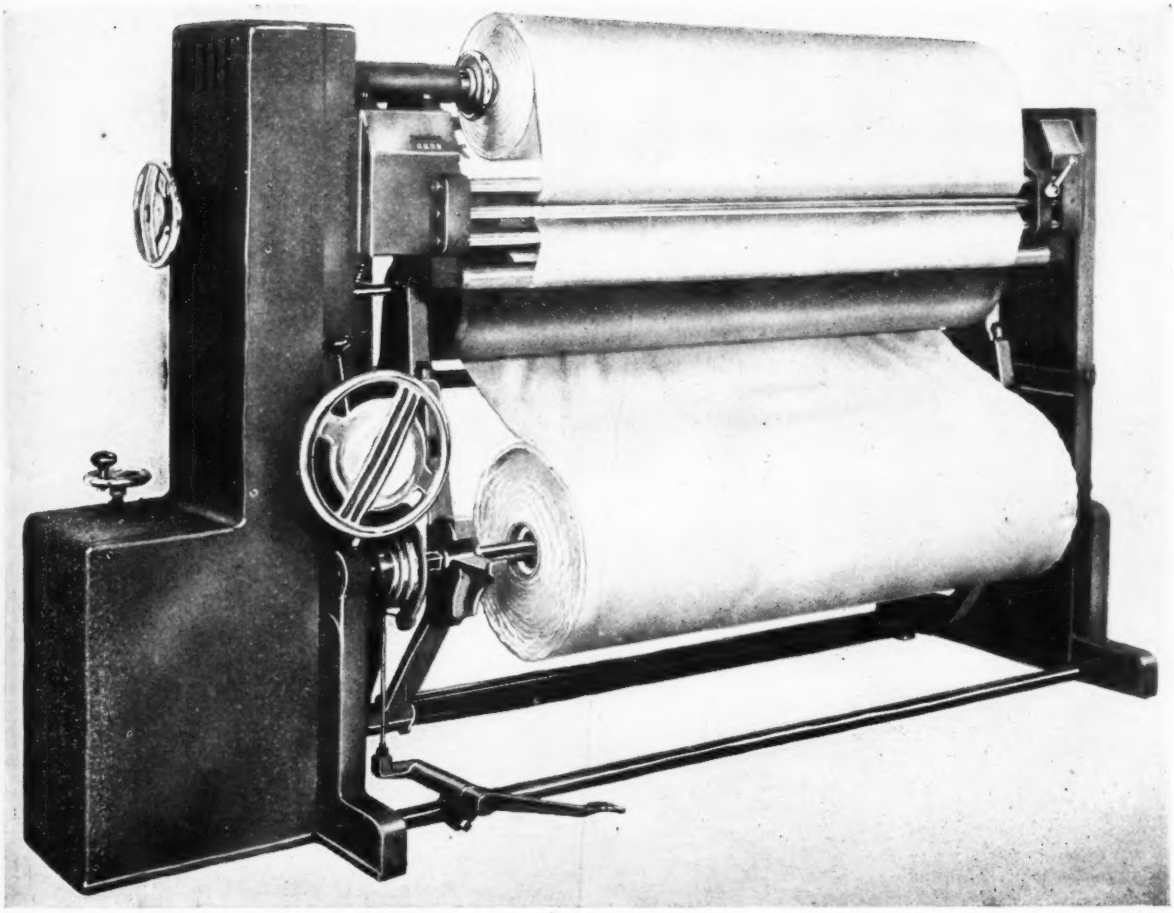

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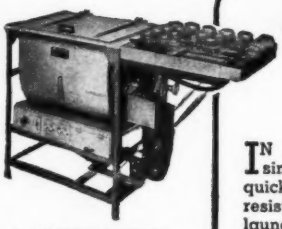

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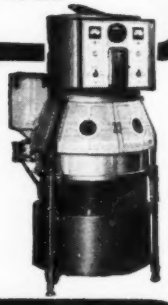

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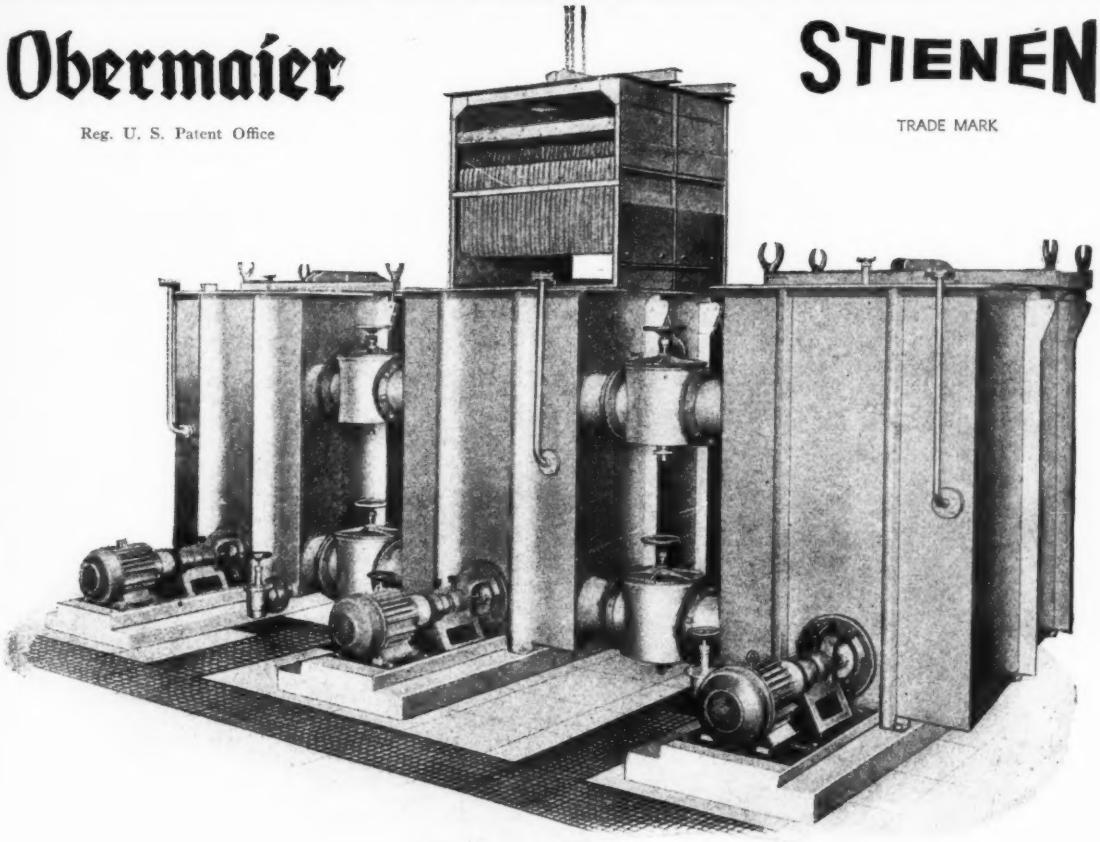

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Manufacturing Chemists
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A COMPLETE LINE OF
DYESTUFFS
for all branches of
TEXTILE DYEING
AND PRINTING—
PAPER AND LEATHER
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Specializing in fast colors
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147-153 Waverly Place New York 14, N. Y.
WAREHOUSES IN NEW YORK and CHARLOTTE, N. C.

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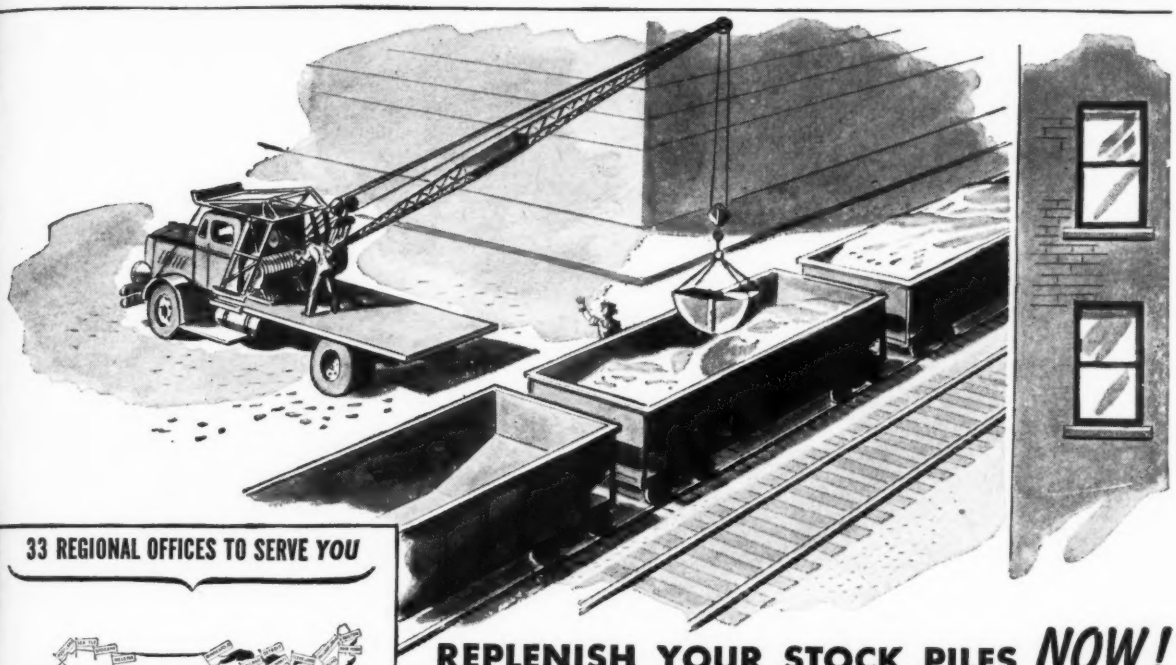

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Synthetic Rubber (Neoprene)
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and most other chemicals

REPLENISH YOUR STOCK PILES *NOW!*

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EXPORTERS:
Most surplus property is available to the export market. Merchandise in short supply is withheld from export and if such items appear in this advertisement, they will be so identified by an asterisk.

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Please supply without obligation, prices, available quantities and locations of items written in below:

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(Describe item wanted)

Name.....
Firm..... .....
Address.....
City.....Phone..... 155-4

All chemicals are subject to priority regulations. VETERANS OF WORLD WAR II are invited to be certified at the War Assets Administration Certifying Office serving their area and then to purchase the material offered herein.

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Zurnoil, with over 60 years textile chemical experience has a number of specialties to meet the requirements of conventional or new fibres, new methods and new finishes.

We shall gladly submit samples for trial runs if you will state your problems.

Specialties for
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STRIPPING
PENETRATING
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LUBRICATION

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Oils for all textile conditioning requirements

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CONFIDENTIAL EMPLOYMENT SERVICE — We invite correspondence (confidential) with Dyers, Chemists, Colorists, Superintendents, Master Mechanics, Office Managers, and others seeking positions and with employers seeking high-grade men to fill vacancies or to make replacements. Charles P. Raymond Service, Inc., 294 Washington St., Boston, Mass. Over 45 years in business.

POSITION WANTED: Textile chemist, broad education, with 15 years practical experience in the finishing and dyeing of knitted and woven outerwear woolen fabrics. Also possess knowledge of cloth manufacture from raw material process to finished fabric. Write Box No. 106.

POSITION WANTED: Textile chemist desires position with small dyestuffs or chemical company. Lowell Textile Institute graduate; one year's experience; veteran. Write Box 114.

WANTED: Sulphur Black, Sulphur Navy, Ponsol Blues, all cotton dyestuffs, spot and future shipments. Write Box 112.

POSITION WANTED: Technical assistant to plant manager. Capable of handling development of new methods and processes in greige mills and finishing plants. Experience includes cotton, wool, silk and synthetics on yarns, cords and fabrics. Write Box 109.

POSITION WANTED: Supt. of dyeing. Graduate of dyeing and chemistry, 14 years experience on raw stock and piece goods, also picking, scouring and carbonizing. Experienced with wools and unions. 35 years old, married. Write Box 113.

Attention Dyestuff Manufacturers and Distributors. Are you interested in contacting a man who has 20 years dyestuff and chemical experience in both technical and representative capacities? Write Box 115.

DRY BOX—VAN VLAANDEREN SILK NET DRYER—52' Long 7' 7" wide. Operates at 275°. Box 119.

POSITION WANTED: Graduate of Textile School of Dyeing and Chemistry. Interested in developing Eastern interests who wish to locate a dyeing and finishing plant in Los Angeles, California. Expert dyer and finisher of all types of piece goods. Now located in Los Angeles, ready to receive instructions to start work. Box 118.

WANTED: Color Chemist; Chemist or Chemical Engineer with 2 or 3 years experience, including some color-matching work. To work with testing and selection of coloring materials for plastics. Supply full personal data with particulars on training and experience and include photograph. Box 121.

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Economical-to-use Lupomin is available in all pHs, in both paste and powder forms, in chemical formulae to meet any fabric requirement—for the dyebeck, jig, quetch or padder. Your inquiry is cordially invited.

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Chemicals PASSAIC, N. J.

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- **FOR YOU**
- **FOR YOUR COMPANY**
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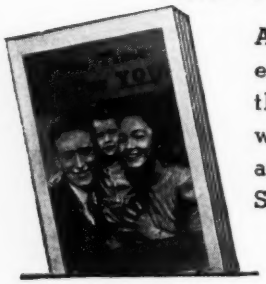

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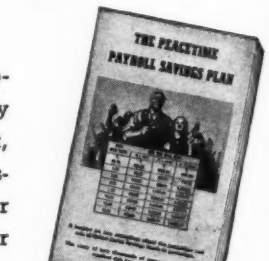

A booklet, published for key executives by the Treasury Department, containing helpful suggestions on the conduct of your payroll savings plan for U.S. Savings Bonds.

Are You Using These Booklets?

If you're not already using these helps to a healthy future, get in touch with your State Director of the Treasury Department Savings Bonds Division. And by all means keep up your payroll savings plan. It's a powerful weapon for the maintenance of a strong, secure economy — today and tomorrow!

The Treasury Department acknowledges with appreciation the publication of this message by

AMERICAN DYESTUFF REPORTER

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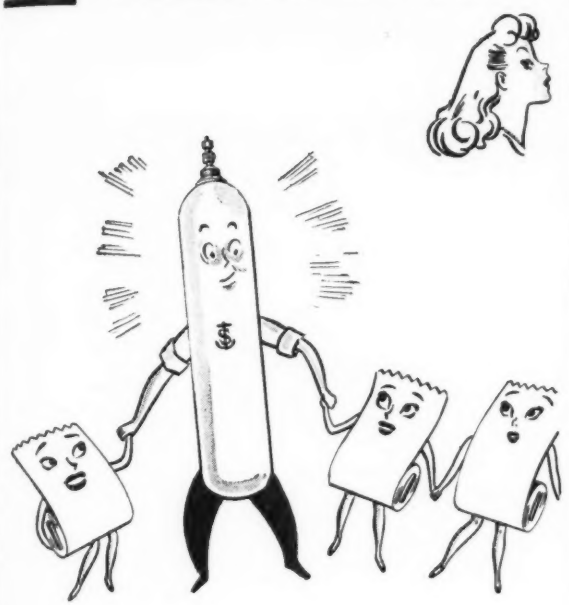

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OF COURSE THE BUYING public doesn't know. For instance, they think cotton fields look white as the driven snow. Shows what you can do when you use SOLVAY Liquid Chlorine as your perfect bleaching agent!

SOLVAY LIQUID CHLORINE PERFECTLY performs all bleaching operations. In the first place it safeguards against spotty bleaching and uneven colors. As a water conditioner, it controls the quality of the water. Add this to its versatility, its low cost, its controlled quality, its highest standards of purity and its dependable performance and you will see why leading textile houses depend on SOLVAY Liquid Chlorine to solve all bleaching problems perfectly.

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BURKART-SCHIER CHEMICAL CO.
CHATTANOOGA, TENNESSEE

MANUFACTURING CHEMISTS FOR THE TEXTILE INDUSTRY

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For a quarter of a century, outstanding textile mills have standardized their wet processing operations with HARTEX chemicals. HARTEX research, keeping pace with the latest development, has met every changing requirement of the textile industry. Always—all ways—Hart Products have done their job in rendering an efficient service to the textile industry.

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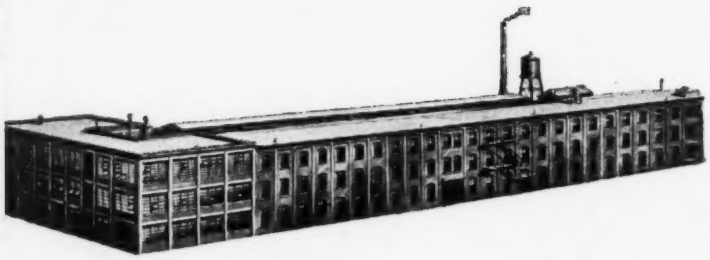
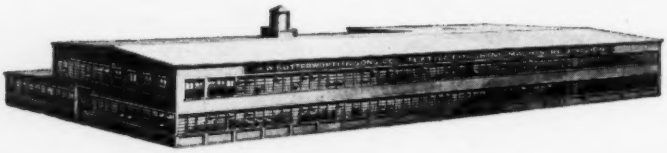
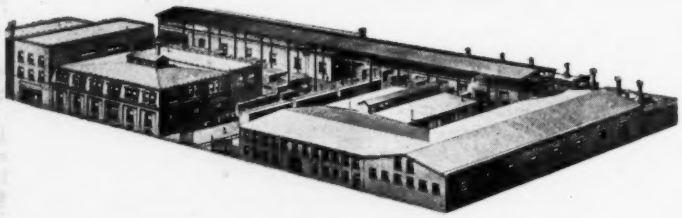


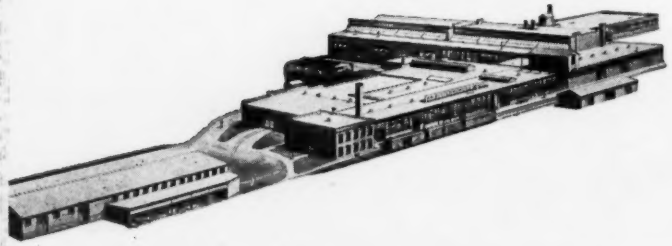
Main Butterworth Plant, Phila. 126,952 sq. ft. of floor space devoted to the production of textile finishing machinery.



Textile Finishing Machinery Division of H. W. Butterworth & Sons Company, Providence, Rhode Island.



Home Office including model plant for test runs and shipping and receiving sections, Philadelphia.



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Butterworth Vat Dyeing Ranges produce mo through color fixation than ever before possible speeds ranging up to 120 yards per minute. Butt worth Equipment in the Vat Dyeing Range includ steamers, compartment washer, padders, dry and folders.

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